SCIENTIFIC AMERICAN
No. SUPPLEMENT 808

Copyright by Munn & Co., 1891.

Scientific American Supplement, Vol. XXXI. No. 808. Scientific American, established 1845. NEW YORK, JUNE 27, 1891. Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

THE MANUFACTURE OF LIQUID CARBONIC ACID GAS.

SINCE the experiments of Faraday, Pouillet and Thilorier on the liquefaction of gases, liquid carbonic acid, the preparation of which had long remained in the domain of science, and was done only in laboratories, and not without some risk to the preparator and his assistants, has become an industrial product, of which the applications are numerous. There are extensive works now that are daily producing large quantities of liquid carbonic acid and distributing it everywhere, and delivering it in a condition that permits of the manipulation of it with absolute security and great precision.

Liquid carbonic acid is a valuable agent, among other things, for the production of artificial cold.

It is extensively used in brewing for the saturation of export beers. In cafes it advantageously replaces compressed air for drawing beer from casks and distributing it constantly, fresh and foamy, to any story.

In the mineral water industry, we find it replacing the apparatus of direct production and furnishing a chemically pure pas.

We meet with it in medicine, playing the most diverse roles, now as a stimulant and now as a local anæsthetic.

For the preservation of food products, it has, according to the assertion of some specialists, an efficacious antiseptic action and is of a most easy application.

In panification, it might even, it is asserted, suppress yeast and the manufacture of barm.

We here limit the enumeration of its varied uses. The reader will have obtained an approximate idea of the importance of the markets for this new industrial product. We shall now give a description of the manufacture of it in Paris.

Liquid carbonic acid is there manufactured by means of the Windhausen system of apparatus installed in the Grenelle works, belonging to the joint stock company La Carbonique Francaise, which we have been allowed to visit. The manufacture includes: (1) The production of the carbonic acid, and (2) its compression and its liquefaction, which permits of delivering it in metal cylinders that constitute true bottles.

1. *Production of the Acid.*—Gaseous carbonic acid is obtained by decomposing natural carbonate of lime by an acid. The apparatus are installed in battery form, thus permitting of a continuous production. Fig. 1 shows the generators of carbonic acid gas obtained from chalk and hydrochloric acid, followed by their washers and purifiers.

2. *Compression and Liquefaction.*—In the installation here presented to the reader, the compressors designed to effect the liquefaction of the carbonic acid are connected, to the number of three, which lie parallel with one another and are fixed upon the motor (Fig. 2). These horizontal double-acting pumps are distinguished from an ordinary pump only in the selection of materials, in the care used in the construction of the details, and in the arrangements taken to secure the lubrification of the rubbing surfaces.

The first compressor, of a sufficient capacity to take from 100 to 150 kilogrammes of carbonic acid gas per hour from the gasometer, at a pressure of from 18 to 30 centimeters of water, compresses this gas to 8 atmospheres. The second sucks this gas from the first and compresses it to about 20 atmospheres. Finally, the third brings it to the definitive pressure at which it will liquefy on cooling.

The gas, delivered at a mean pressure of 60 atmospheres by the third compressor, is forced into the condenser, in which liquefaction is effected.

This condenser, which is represented by the cylindrical vessel shown to the left in Fig. 2, is made of boiler plate and contains 5 worms, whose length is 700 meters and whose surface is 70 square meters. The carbonic acid traverses these worms in a direction opposite that of the water that cools them. A special cock on the delivery pipe serves to regulate the exit of the liquefied acid and to cause the flow of it to correspond to the production of the compressing pumps. The pipe that delivers the liquefied gas terminates in a stop cock arranged for connection with the iron cylinders serving to hold it, by means of a flexible tube provided at its extremities with coupling nuts, one of which screws upon the stop cock of the delivery pipe and the other upon the cock of the cylinder to be filled, which stands upon the platform of a weighing machine.

The cylinders, after being connected with the flexible tube, are accurately tared while empty, and, in half a minute, receive a charge of 10 kilogrammes of carbonic acid, representing a volume of about 10 liters. These cylinders or receivers that are filled with liquid carbonic acid are of forged iron, and have a capacity of about 12 liters, and are registered, like the worms, for a pressure of 250 atmospheres. To their upper extremity is screwed a special cock that forms an integral part of the cylinder.

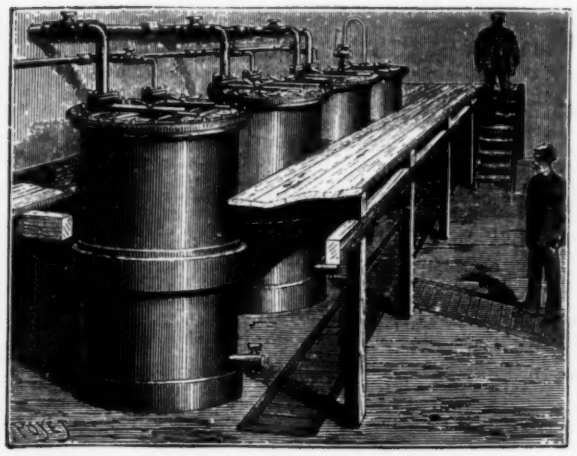


FIG. 1.—APPARATUS FOR THE PRODUCTION OF CARBONIC ACID.

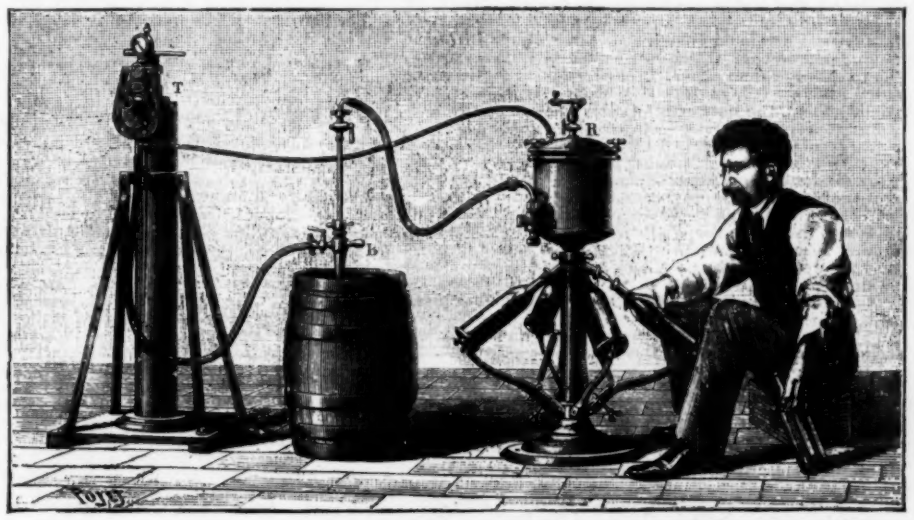


FIG. 3.—BOTTLING BEER UNDER THE PRESSURE OF CARBONIC ACID

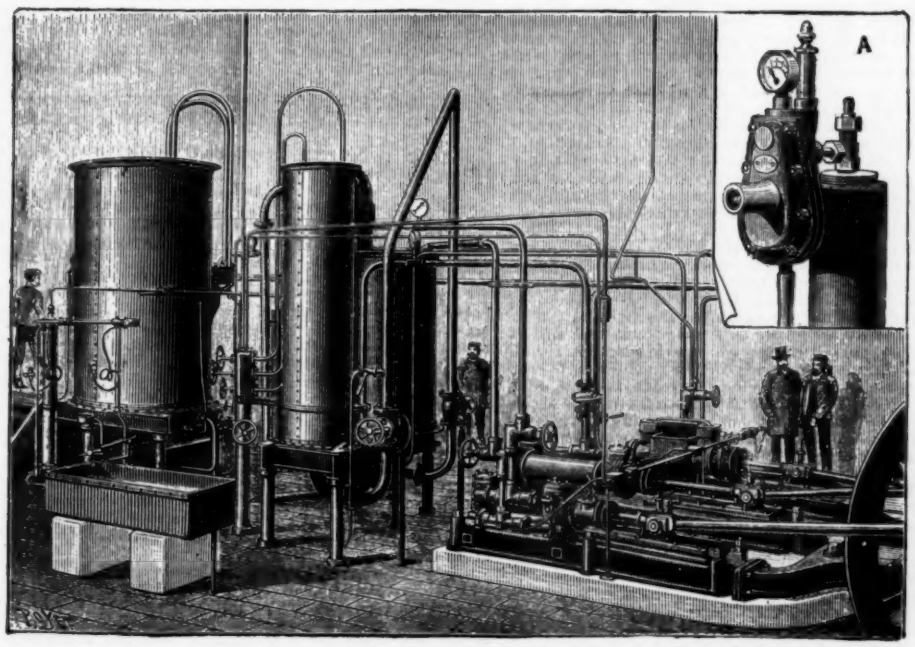


FIG. 2.—COMPRESSORS AND CONDENSERS.—A, Automatic expansion pressure regulator.

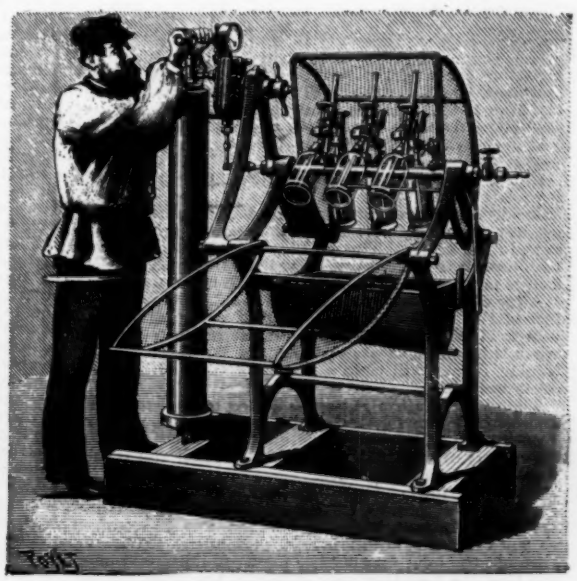


FIG. 4.—CHARGING SIPHONS.

In the corner of Fig. 2, at A, may be seen the upper part of one of these iron cylinders, with its special cock and the pressure gauge with which it is connected. The liquid carbonic acid is inclosed therein under a pressure that rises by 67 atmospheres at the temperature of zero.

The works at Grenelle, which we visited with great interest, not only manufacture liquid carbonic acid, but also, and simultaneously, ice designed for public consumption. This manufacture is based upon the principle common to all liquefaction frigorific machines. We shall say a few words concerning it.

The frigorific effect necessary for freezing water in an apparatus called an ice generator is obtained through the spontaneous vaporization, under a pressure reduced to 25 atmospheres, of a mass of liquefied acid. The ice generator consists of a large reservoir filled with a solution of chloride of calcium incongealable down to 18 degrees below zero. In this bath are suspended 450 moulds filled with the water to be frozen. There also circulates in it a system of three worms through which passes the carbonic acid, whose change of state constantly removes enough heat from the solution to keep it at a temperature notably below zero. The water in the moulds is converted into blocks of ice. Every quarter of an hour, 15 moulds of ice are removed and are replaced by 15 other moulds, filled with pure water.

The liquid carbonic acid, delivered in iron cylinders, is, as we have already stated, used in breweries, where it is employed in the saturation, bottling, etc., of beer. Fig. 3 represents a bottling apparatus. Here, T is the metal cylinder of liquid carbonic acid sent out from the works.

When the cock at the upper part of the apparatus is opened, the carbonic acid enters the keg, B. The gas acts by compression and causes the beer to flow into bottles arranged beneath the reservoir, R. It will be understood that, through pressure, it is thus possible to cause beer to ascend from a cellar to a cafe on a story above. It is in this way that beer glasses are usually filled, the beer coming directly from the cask.

Fig. 4 represents the apparatus designed for the charging of siphons of seltzer water. To the left of the engraving may be seen a workman opening the cock of the cylinder of liquid carbonic acid. The gas escapes and charges the water contained in the siphons. These latter are placed in a cradle that oscillates, so that the gas and the water shall be constantly agitated. The cradle is covered with wire gauze, in order to protect the workman in case of the bursting of the glass siphons.

The industrial manufacture of liquid carbonic acid now constitutes an operation of a great importance, and furnishes a product whose applications will assuredly become more and more numerous.—*La Nature.*

FLOATING SOAPS.*

FLOATING soaps can be prepared according to various methods, of which two will suffice—the preparation from fresh materials and the preparation from trimmings from cocoanut oil soap. This latter will probably give a very welcome opportunity to many manufacturers to advantageously dispose of the heaps of trimmings often left over.

The following is a formula for preparing a white floating soap from fresh materials. The color of the soap will of course depend largely on the quality of the oil used:

	Pounds.
Cocoanut oil	88
Soda lye, 38° B.	46 2
Potash lye, 25° B.	2 2

Melt the cocoanut oil in the usual manner, filter into capacious jacketed kettle or one placed in a water bath and heat to about 122° F. Then add the lye, stir well for about ten minutes, and then cover up the kettle. Allow to saponify and then thoroughly stir again. The soap will now have the appearance of fine woolly grains.

In the foregoing process but little fire or steam is necessary. Twenty-two pounds of well warmed calcium chloride solution of 20° B. and 88 pounds of hot water are now gradually added with constant stirring to the curd in the kettle. The soap is worked up thoroughly to complete solution, but very little heat is required, as it is not necessary to make the soap boil.

After obtaining complete solution take a lye cylinder full of the soap solution from the kettle, allow it to cool to 77° F., and sink a lye hydrometer in the liquid, when this will indicate a density of 50° B. This particular degree will yield a floating soap having a medium weight.

The soap solution is then allowed to cool to 77° F., and a stirring kettle filled about one-third full with the cooled soap. This aqueous fluid mass is then stirred vigorously until transformed to a stiff foam and is then put into the flames at once.

The prescribed temperature of 77° F. must be carefully adhered to, for if heated to a higher temperature, say 100° F., or over, much more time will be required to work up the liquid into a permanent foam, and through the long stirring the foam would be so puffed out that the resulting soap would be too light. On the contrary, if allowed to cool too much, the soap obtained will be too heavy, because the formation of the foam takes place too rapidly, and the soap is not allowed sufficient time to swell in the kettle.

Floating soap should not be dried in a warm room nor in a drying oven, as, if this is done, the soap will shrink a great deal and become fissured. It is better to allow the entire block as it comes out of the form to stand for several weeks in an airy light place, then cut into tables, allow them to dry for several days, and then cut up into bars or cakes.

Another process, that of making floating soap from trimmings, is quite simple. For instance, place 220 pounds of the trimmings or scraps from cocoanut oil soap in a jacketed kettle or on a water bath. To dissolve this about 33 pounds of potassium chloride solution of 20° B. and about 132 to 154 pounds of water should be added to the scraps in the kettle, the quantity of solution and water required being of course dependent on the degree to which the scraps have dried out.

Considerable heat is applied at first and the scraps diligently broken up to facilitate their solution. Strips and cubes of soap should have previously been passed through a planing machine. When very old, dry scraps are used, it will frequently prove very difficult to effect their solution. In this case solution can be accelerated by strewing over the above quantity of soap from 2 to 4½ pounds of salt.

The trimmings of cocoanut oil soap mentioned in the above process should not be from "filled" soap, as such, filled for instance with water glass and soda crystals, are not suitable for floating soap. The material used for filling renders the soap brittle and coarse, and when cut and planed the surfaces of the bars and cakes do not become smooth. When used in too large quantities salt causes the same result in floating soaps. These "filling" solutions have also an influence when measuring the degree of density of the soap solution.

If it is desirable to work in scraps of floating soap, they should be added to the already dissolved soap mass in the kettle, together with the necessary amount of water. They will then dissolve very easily.

When putting the soap solution into the kettle for stirring, it is advisable to allow it to pass through a fine sieve to get rid of any bits of wood, paper or dirt which may be present.

As to the color of floating soap, it may be said that white is by far the favorite color.

By using small quantities of tallow or lard in making floating soaps they are rendered firmer and more solid and also more economical in use.

The perfume should be added to the soap in the stirring kettle before the soap begins to form a thick foam. The chief perfumes used are lavender, caraway, white thyme and fennel oils.

This soap can be cut with a fine steel wire; for planing the bars a very fine sharp plane is required.

* Der Seifenfabrikant. *Chem. Tr Journal.*

NOMENCLATURE OR VERNACULAR IN BRICK MAKING.*

By S. K. FLETCHER, Indianapolis, Ind.

HERE at Indianapolis, one of the first operations of the brickmaker is to dig his clay, or turn his clay in the field. The term field is used, as we can only work the clay 18 to 24 inches deep, and it really requires a good sized farm to run a brickyard of any very great capacity; both terms, digging and turning, meaning the operation of spading over in the winter or early spring all the clay for the season's work, by first digging a trench, say 2½ feet wide, and as deep as it will work, then another strip of similar width, throwing the top into the bottom of the trench first dug. This brings the bottom clay of the second trench on top of the first, and thus the field is dug over. The work being paid for by the thousand, counting 64 cubic feet to a thousand brick. And no one in this locality would think of making brick without first preparing his clay in this manner.

For yards moulding by hand the clay is carted to the pits by men called clay carters or pit fillers, where it is soaked, meaning that water is applied of sufficient quantity to thoroughly percolate through and dampen every part. After a sufficient length of time it goes through the tempering process, which is done with a tempering or mud wheel working on a shaft with a ratchet, which causes it to travel in and out until the clay has been transformed into the perfect mud state. Then the pit is smoothed or slicked down with a board called a slicking board, hitched to the wheel shaft, on which the driver or pit man will ride around a few times until the surface is as smooth as a cement walk; this prevents the pit drying out. The mud is then taken to the table on a mud barrow by a mud wheeler. The moulder sands his table and then rolls his walk, by which is meant he throws or sprinkles sand on the walk to prevent the mud sticking; and with his hands he cuts from the mass in front of him a sufficient quantity for one brick, rolls it on the sanded table until he gets it into the proper compact form, and then with a quick firm movement drives this mass into a mould with such force as to fill every corner. When all are filled he caps the mould with his bow, which is a short stout bowed piece of wood, with a steel piano wire string. The moulds are then taken to the yard by the off-bearer, who dumps them. To give a smooth surface to his yard before dumping the brick upon it, he lutes it with a scraper of proper form with a steel cutting edge, called a lute. On the Hudson River all the brick dumped on the yard have the rough edge caused by the vent in the mould pressed down smooth by a boy with a tool called a stamper, made for the purpose. They call it patting or stamping them.

When sufficiently dry to touch without making finger marks they are edged in some localities and turned in others, this turning them up on edge to facilitate drying. When dry enough they are hacked on hacking boards, which are one and one and a half to two inches thick; here the brick complete the drying, if not all ready for the kiln. The hacks are protected from the weather by splash boards set up against the sides and caps on top.

The man conveying the brick to the kiln is a brick wheeler, wheeling on a brick barrow. On the Hudson River, where the brick are shipped to market by boat, there is a green brick wheeler and a burnt brick wheeler. The man placing the brick in the kiln is a "setter" the country over, and the man passing the brick from the barrow to the setter is a brick tosser. The men working in the kiln after burning are called kiln shed men in one place, tossers out in another, and brick pitchers in others.

In kilns we have scoved in one place, and the cased up in others, they being one and the same. The kiln being first set under the kiln shed, so many stretchers wide, meaning the width is a given number of bricks lengthwise, and so many bricks high, meaning so many bricks on edge. The setting is benches between the arches almost universally. The projecting courses to form the arches are overhangers in some places and jets in others. There are two-brick benches and three-brick benches. Above the arches the setting is generally 3 on 3. When setting in this way, every two brick is called a topping in some localities; in some places they are set diagonally across each other, called skintling. The kiln is finished out on top with plating in most places, but in some it is called flatting, and in others splatting. It is generally double; the first course laid with green brick flat, but loose, and the second or top of soft or salmon brick, tight.

The casing or scoving which forms the outer wall of this class of kilns is laid up as the setting progresses, usually about 12 inches thick at the bottom, and tapering to 4 inches at top. At the bottom the eyes are formed, which are the openings through which to fire the arches. Another small opening is formed through this casing just opposite the top of each arch, called a peep hole, I think, in all localities.

Daubing the kiln is to plaster it all over with soft mud, making it air tight as near as possible. Propping the kiln is bracing it to prevent the expansion by the intense heat throwing it open.

The first thing in burning a kiln is to water smoke it, in some sections, drying off in others, and steaming in others, all meaning to absorb thoroughly and dry out what moisture remains in the brick by slow and careful firing, which usually requires from three to four days. And right here let me say that I consider this one of the most important parts of burning. I believe that more brick are ruined, more money is lost, by improper water smoking or drying off than by anything else, and it is caused by too much haste. "Slow and steady" should be the motto from beginning to end in burning brick, and when the kiln is blowed out, and every eye closed and daubed, and every crack that has opened in the casing by the heat is plastered over, let no man prevail upon you to give it air until it has sufficiently cooled to thoroughly anneal or temper the brick. Cold air at this time can do an immense amount of mischief.

Burning in the ordinary kilns with wood, firing for the heads, is called mouth firing, and for the center is called sliding. Firing with coal, baskets hung at the mouth of the eye are used with short grate bars.

What are called clamp kilns, or clamps, are kilns built with permanent walls. Patent kilns are all built with clamps, or permanent walls with furnaces on the outside, and it is the manner of construction of these furnaces in which the patents are claimed. The old Wingard kiln was the first patent kiln that I know of in this country, and about all the others we have now are offshoots from it. The great beauty of kilns of this character is that the furnace being entirely outside, it becomes a caloric kiln. Cold air cannot reach the arches, hot air only reaching the inside of the kiln, and with judgment and care there is no reason why good brick should not be the result of burning in any of them. In burning the kilns are designated as heads, quarters, middles, and centers.

On yards running by machinery the terms vary. On one large yard down in Connecticut, where the clay is deep, it is thrown down by dynamite, discharged by electricity. And this yard of Merwin's is run with the system of a first national bank. Here is one man called a bank boss or foreman of that department. The man who attends to the blowing up business is a bank borer. And the men who cart the clay to the machine are bank cart men. The man who attends the pug mill is called a pug mill tender; on other yards he is called a pug mill man, and at other places he is simply pugger.

Where the clay is shoveled direct from the soak pit into the machine the hands are called pit men, also pit shovelers. Then there is the sander on yards making in sanded moulds. The man who stands in front of the machine and receives the moulds as they come out is called a striker in one place, a striker off at another, also a moulder and a capper at others. The pallet boy is the boy who places the pallets on the dump table. The dumper is the man who receives the moulds from the striker and dumps the brick upon the pallets. The truckers, also called truckers off by some, wheel the pallets to the yard for hacking, or to the yards for stacking.

Hacking pallets are usually conveyed to the kiln without the brick being removed, the pallets with the brick upon them being hacked on brick barrows arranged for the purpose, or upon mule trucks. Where the rack system is used, the brick are generally taken off the pallets and hacked on the barrows or mule trucks to be conveyed to the kiln.

Down in New Orleans, where our friend Blaffer lives, the place where the water runs away from the river instead of running into it, which is also the home of the manly art, bricks too are made in very great quantities. The Blaffer Brick and Lumber Co. have a yard that is a model of neatness. This is a river yard, and the clay used by such yards is called batture. It is the silt which floats down the river during the high water, and settles in pockets or eddies formed to catch it. When the water recedes this dries out and is then carted outside the levees into great banks ready for use. A brick yard has been run at this same place for nearly forty years. Each year the river is sure to rise, and the silt to come down, and the batture formed for another sea on's work. Back from the river the clay is what is called buck shot, because when dug it breaks up in little hard square pieces.

The brick at New Orleans are graded, first as foundries, which are the softest, and used for lining crucibles; then the salmon for chimneys. They call their best brick bench brick, and all the others clinkers, which are used for foundations. On the old yards around New Orleans they use mud or tempering wheels that would be a curiosity to a Northern man. They are fully 12 feet or more in diameter, with a broad, solid tire and rim. The clay is only about 6 or 8 in. deep in the pit, and is simply mashed in tempering it. The shaft on which this wheel runs has no ratchet, and the wheel is made to travel in or out by being thrown off a center at its axis. On these yards they use three brick moulds, dumping on narrow pallets split out of hemlock. On one of these yards run by an old French Creole he told me that his pallets had been in use for over 35 years.

Down in the Old Dominion at Norfolk, where our venerable friend Oldfield lives, you will hear the antebellum vernacular used more than anywhere else in the South, and whenever I think of Norfolk it reminds me of the sign hung in front of a restaurant on one of the back streets of New York. It said, "This is the place where good oysters is got." However, this vernacular is fast changing, but to this day the work is carried on by song. Each man or boy sings as he goes through with his work or task. After "de wah" the colored people did task work. Now they take stints.

* A paper read before the National Brick Manufacturers' Association, Indianapolis, 1891.—From the *Brickmaker.*

They used to cut the clay by tasks, so many spits, now so many yards. They turned a walk for the brick, but now that the machine has come in, the walk is out of use except for the old black Joes. In burning, the old colored man glistered his kiln if not settling to suit him, now he rustles it if he wants more heat. The old man off-bore the brick, the young man carries or trucks them off. The old man done finish his day's work, the young man gets in the day. The old man was done on Saturday, the young man is through the week. The old man on Saturday received his rations and went away happy, singing a hymn, the young man presents himself as promptly for his pay as though his skin were white, and counts his money to see that he has not been cheated.

In most places brick that come from the machine imperfect are called muleys, and those that are left on the yard as unfit to go into the kiln are called old hides. If some part of the kiln gets too hot you are apt to have clinkers, or brick melted together, or vitrified. Arch brick which are blackened on one end are called nigger heads. On the yards where coal dust is used, if it is not properly distributed and mixed, some brick will be swelled or puffed out; these are called lammies. The terms for the different brick in the kiln almost all over the country will run as arch, or eye brick, bench brick, back stretchers, face brick, pavers, select hard fronts, light fronts, alley fronts, salmond, soft and headers, which are the brick up the heads, one end hard, the other salmond. Kiln run and merchantable mean foundation, fronts and flue, sufficient for building, but in this locality does not mean the entire run of the kiln. Pavers do not belong under that head. In Cambridge, Mass., the terms up and down hard mean the whole kiln except the very soft at top. Where coal dust is used these heads are made especially with an extra quantity and burn hard but dark. In Cambridge there are six yards making over sixty million sand moulded brick per year and three other yards making over eight million water struck or slop brick. The clay for making these slop brick is taken direct from the bank to a drying yard, torn to pieces by a harrow, when dry, is rolled and harrowed again, then goes to a soak pit directly behind the machine. This is the only place I know of slop brick being made to any great extent at the present day.

In burning with natural gas I have been unable to get hold of any new terms, except in one locality they go through with a performance at the end of the operation, just before closing the kiln, they call blasting. It is a sort of a farewell. They turn on a full head of gas and shoot the flames 15 to 20 ft. out through the top of the kiln, and a blasted performance I call it. In some localities they blast every hour. Another place where they make splendid burns the flame is driven up until just before closing it comes through the top in little long flames, say a foot high, called candle sticks, and when the candle sticks are well through, they close her up.

AN INEXPENSIVE MERCURIAL AIR PUMP.

By R. W. WOOD, Jr.

FOR the benefit of those who have felt the need of a good mercurial air pump, but have been unable to procure one, owing to their high cost, I give directions for the manufacture of a serviceable and, at the same time, inexpensive article, which will do as good work as any on the market. The cost should not be over $3 exclusive of the mercury, which will probably raise the whole bill to $10. This may seem high, but mercury is a good investment, if not allowed too much freedom, and may be sold for about the same amount, when its use is no longer required.

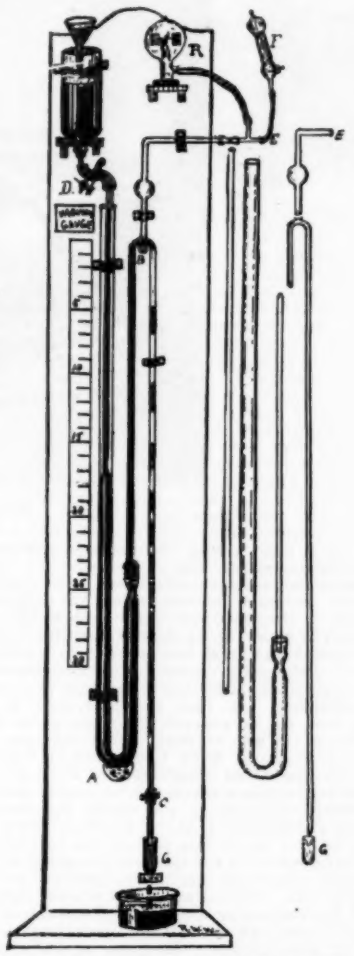
A little skill in glass blowing and welding is necessary. An hour's practice, however, should enable any one to perform the simple operations required in uniting the tubes of the apparatus. The materials necessary for the construction, are as follows: a piece of soft glass tubing 5 ft. long, with a bore of about 3/8 of an inch (1 centimeter); three pieces, each 5 ft. long, with a bore of 1/4 of an inch, having fairly thick walls, say 1/12 inch. If the bore is much over 1/8 of an inch, the pump will not produce a good vacuum. Two or three feet of thick-walled rubber hose (the kind known as "combustion hose"), to connect the pump with the vessel to be exhausted; a quart bottle and a brass screw clamp. There will also be required a blast lamp or blow pipe for welding the glass. I shall presuppose that the reader understands how to unite glass tubes, and weld T joints. If he does not, he may learn in a few minutes from any one accustomed to glass blowing or by perusing any book on the subject.*

The large tube is to be drawn down to half its diameter about an inch from one end. The bore of this contracted portion should be too narrow to admit one of the smaller tubes. At a distance of 15 in. from this end a U bend is to be made. To make a good bend, it is best to heat the tube in the broad flame of a fishtail burner, turning it constantly. A similar bend should be made 10 in. from the end of one of the small tubes. This bend should be made as uniform and even as possible, as it is here that the mercury does its pumping. A piece about two feet long is to be cut from one of the small tubes and welded into the U bend on the outside, after the manner of a T joint, the wall of the bend being first blown out. Before welding this piece on, it is a good plan to blow a small bulb about 6 in. from the end next the joint. To prevent the bend from becoming distorted during the process, it is necessary to tie the two parallel arms to pieces of cork placed tightly between them; this keeps them parallel while the bend is softened, and prevents their twisting. A piece of hose should be slipped over the short arm, to blow through, during the welding, the other openings being closed of course. In order to make a good joint that will not crack on cooling, it is necessary alternately to blow out and melt down the walls, being careful that no rupture takes place. This is the most difficult part of the job, and it is well to practice on some small pieces before trying to unite such long tubes. A piece must now be welded on to the short arm, of such a length that, when it is inserted into the cup on the lower end of the large tube, the T joint shall be at least five inches below the upper end of the large tube. The diagram will explain this. Of course if it is possible to get a tube eight feet long, this last process can be omitted, the long U being made of one piece. The upper arm of the T is to be bent at right angles above the bulb, as shown in the diagram.

* Practical Glass Blowing. Munn & Co.

The tubes are now ready to be mounted. A board seven feet high and ten inches wide should be firmly fastened in an upright position to a base, and the tubes mounted as shown. The lower bend of the large tube should be supported by half of a large cork, A, firmly fastened to the board, and the tube itself securely bound down by strips of leather. The short arm of the long U should be inserted in the little cup, and the bend supported by a good sized screw, B, covered with a bit of rubber tubing, the long arm being raised from the board, say half an inch, by putting a small cork under it eight inches from the bottom, and strapping it down upon this with a strip of leather, C (a hole should be bored where the bulb comes). The cup should now be filled with some strong, air tight cement. Sealing wax will do, but is rather too brittle. The best thing for the purpose is a mixture of pitch and gutta-percha, melted together and applied hot. Care should be taken not to let it get under the bottom of the small tube, thus plugging it up.

The tubes now form a continuous system, and the reservoir for the mercury is the only remaining piece to be made. The bottom should be cut off a quart bottle, by winding a string around it, soaking in alcohol, igniting, and finally plunging into cold water. A better plan, perhaps, is to bore a hole in the bottom of the bottle with a broken file, kept moistened with a solution of camphor in turpentine. A perforated rubber stopper, fitted with a short glass tube, is inserted, and this is connected with a 40 inch glass tube by means of a short piece of combustion hose. This tube runs down the large one, *and its bottom should be at least* 32 *inches*



A NEW MERCURIAL AIR PUMP.

below the T joint. A brass screw clamp should be put on the connecting hose, to regulate or stop the flow of the mercury, D. The bottle must be supported, in an inverted position, directly over the tubes, by means of a wooden bracket.

A glass funnel passes through the hole in the bottom of the bottle; this contains a cone of filter paper having a small hole in the bottom. All impurities in the mercury will cling to the paper, which should be changed often.

The bottom of the long arm of the U should dip into a small test tube, G, furnished with a broad lip. The lip can be made by heating the mouth of the tube and then poking it out with a smooth iron nail. The mercury flows out through the lip and is caught in a basin beneath. If the bottom of the long tube is bent up at two right angles, thus, L, the test tube may be dispensed with, and the mercury allowed to fall directly into the dish.

To run the apparatus a good sized cup of mercury will be required. The more mercury there is, the less trouble there will be in continually transferring it from the basin to the reservoir. Close the clamp first, also stop the exhaust tube at E, then pour the mercury into the funnel. It will run through in a few minutes, leaving a black scum on the paper unless pure. Now open the cock a little, and the tubes begin to fill, the fluid rising in a double column in the large and small tubes. As soon as it reaches the T it will flow over and down, dragging air from the exhaust tube. Stop the flow. You will notice that the column in the large open tube does not rise above the T; hence it cannot overflow. Make a paper scale, divided into 30 inches, and duly marked; paste this beside the large tube, so that the top of the scale is opposite the top of the mercurial column. Everything is now ready for the process of exhaustion. Connect the exhaust tube with the vessel (say a Geissler tube, F) by means of a piece of combustion hose, which should fit *very tightly* over the tubes. Open the cock a little, and the drops of mercury immediately begin to tumble over the bend, and go chasing each other down the long tube. They should go over quite slowly, say two a second, and the spaces between them will be quite long at first. Notice the mercury column in the large tube; it is falling rapidly, and by observing the scale you may know exactly how the exhaustion is proceeding. When the column reaches the 15-inch mark, exactly one half of the air has been removed from the vessel. As the exhaustion proceeds, the air between the falling drops becomes thinner and thinner, and finally we have a solid column in the long tube, standing 30 inches above the mouth of the test tube, upon which the drops fall with a sharp metallic click. This hammering of the pump shows that the exhaustion is very perfect, the air being too thin to serve as an elastic cushion. The pump should be allowed to hammer away for a few minutes, when the vessel may be disconnected, either by fusing the glass tube connecting it with the hose or in any way that is desired. Care must be taken to keep the reservoir supplied by transferring the mercury from the basin to it. It is best to have two basins, and exchange them at intervals. With this pump, Geissler and Plucker tubes, or small electric lights, may be exhausted, and any experiments requiring high vacua may be performed. The writer has obtained a vacuum so perfect that a Crookes radiometer would not run in it. This makes an excellent test for such a pump: Cut off the tip of the tube through which the radiometer was exhausted (it spoils the instrument, of course) and connect it with the exhaust tube. When the exhaustion has reached a very perfect state, the vane will begin to turn, if exposed to strong daylight. This is an excellent vacuum, but if the pump is a good one, and is allowed to run on for some time, the tenuity of the air will be such that the vane will cease to turn. The radiant energy of the molecules becomes too feeble to cause rotation. You may connect the radiometer by a T joint as a permanent fixture of the pump, R. It serves as an excellent gauge. The height of the column in the large tube does not measure the extreme tenuity. It only shows the pressure in the early stages of the process.

THE SPIROGRAPH.

ALL draughtsmen, architects and engineers who have to draw curves will appreciate the advantages that may be offered by a really practical and rapid process.

It is customary to draw volutes by the geometrical two or four center method, but every one knows how

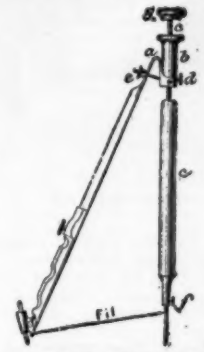


FIG. 1.—THE SPIROGRAPH.

long it takes to do this, and how little precision there is, on account of the difficulty presented by the junctions of the successive arcs.

Struck by these inconveniences, several inventors have devised special apparatus for drawing volutes in a continuous line, but all such instruments had the same defects, viz., they were difficult to use and were very expensive.

The spirograph that we present to our readers, and which was invented by Mr. De Baecker, an engineer, gives spirals that are absolutely regular, and, moreover, the manipulation of it is one of the easiest of matters.

It is somewhat in the form of a pair of compasses, the drawing leg of which (Fig. 1) is fixed by a spring, *a*, to a sleeve, *b*, capable of revolving around the leg *c*,

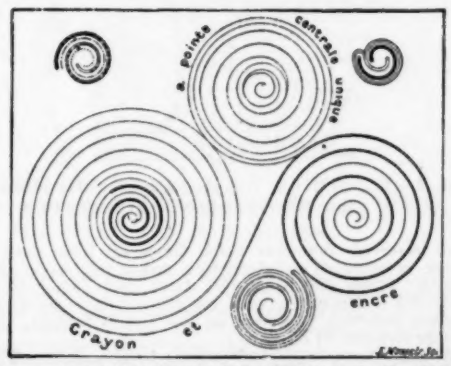


FIG. 2.—SPECIMEN OF DRAWINGS OBTAINED WITH THE SPIROGRAPH.

and sliding vertically upon it. A binding screw, *d*, permits, when necessary, of firmly holding the sleeve, so as to convert the spirograph into ordinary compasses. Another screw, *e*, regulates the distance of the pencil holder from the fixed leg, *c*. At the base of the latter there is a socket in which may be held, by means of the screw, *f*, one of a graduated series of dry points. Near the socket there is a small aperture into which is passed a thread that is attached at its other extremity to the base of the drawing leg.

In order to draw, we take the button, *g*, in the left

hand and hold the leg, *c*, in an invariable vertical position, and with the right hand give the sleeve a rotary motion.

This motion causes the thread to wind around the drawing point and forces it to approach the dry point in describing infinitely small arcs whose radii continue gradually to increase. We thus obtain an evolute of a circle having regularly spaced spirals. The curve obtained may be right-handed or left-handed, according to the direction in which the sleeve is turned (Fig. 2).

As the distance apart of the spirals is equal to the development of the circumference of the dry point increased by the thickness of the thread, a series of dry points of increasing diameter will permit of practically drawing spirals of any interspacing desired. Either a pencil or an ink drawing may be made with the apparatus.

Made of metal, the spirograph will be highly appreciated by draughtsmen, engineers, and architects, to whom it will prove a saver of time; made of wood, and of a larger size, it will prove very useful for blackboard drawing in schools. Finally, it will be of service to sculptors and modelers.

NEW REGISTERING BAROMETER.

WE have often had occasion to bring Mr. Redier's registering apparatus to the attention of our readers, and we long ago described the large registering barometer devised by this learned constructor for observatories and meteorological stations.

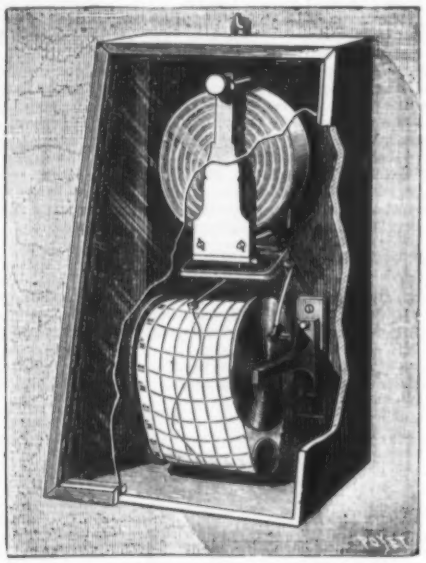


FIG. 1.—REDIER'S NEW REGISTERING BAROMETER.

The instrument that we now call attention to is of very reduced size, moderate price, and regular operation, and appears to us worthy of recommendation to savants and amateurs.

As shown in Fig. 1, this registering apparatus, of simple pattern, consists of an aneroid box, whose actuating disk is connected with an inscribing style. The apparatus is protected against the resistances due to the friction of the style upon the paper that receives the trace.

The pen comes into contact with the paper in the following manner:

Its extremity contains, in a conical reservoir having an aperture at the point, a certain quantity of ink.

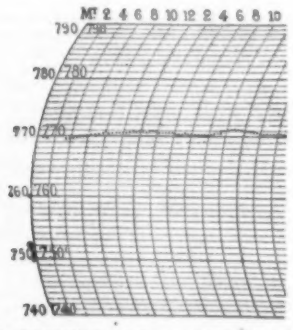


FIG. 2.—FACSIMILE OF A CURVE OBTAINED WITH THE REGISTERING APPARATUS.

This reservoir descends three times an hour with a quick movement, and deposits a dot of ink upon the paper. These dots, separated from each other by a fifth of a millimeter, give a quasi-continuous curve of perfect accuracy. As soon as the dot is formed, the needle resumes its liberty.

A single barometric box suffices to actuate it. The instrument operates eight days without requiring to be wound up, and the paper is changed when the winding is done. The hour is represented by 1¼ millimeters, and the millimeter of mercury by 1 millimeter.

These barometers, designed for the public as well as for scientists, are so arranged that the paper has not to be changed if one is not obliged to preserve the curves. This is a point of greater importance than might be thought *a priori*. We have often happened to see registering instruments stopped because there had been a neglect to change the paper at the desired moment. In the new instrument, therefore, there is an innovation which will be especially appreciated by amateurs who are not obliged to form meteorological archives, but for whom it suffices to compare the barometric curve of the day with that of the days preceding.

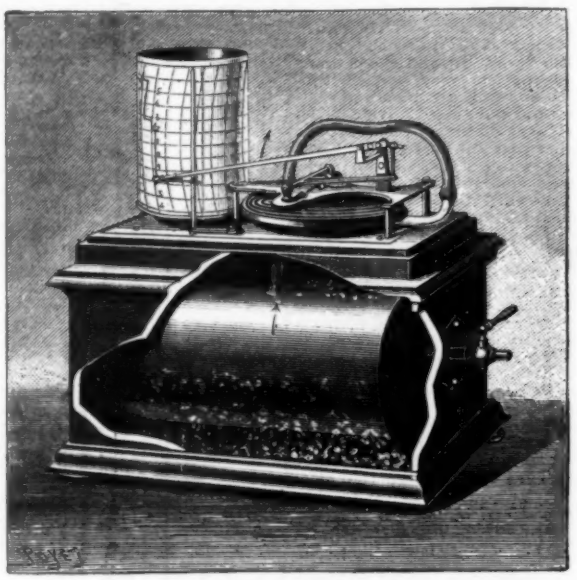
In Mr. Redier's new apparatus the recording cylinder is made of a white material that can be cleaned like enamel, porcelain, or celluloid. In measure as it revolves, the old dots are effaced in order to make way for those that are to follow. This arrangement, we repeat, is very ingenious, for the changing of paper on the cylinder is an annoyance that many observers would be pleased to avoid.

The adoption of a permanent receiver of white material does not exclude the use of paper for meteorologists who would like to preserve their documents. The white material can be replaced by paper at will, and *vice versa*.

In Fig. 2 we give a fac-simile of a fragment of a curve obtained by the new registering apparatus. It is clearly seen that the curve is formed of small equidistant dots. These latter are made upon the paper every twenty minutes. They are well formed and sufficiently close together to give the impression of a continuous line.

THE STATOSCOPE.

UNDER the name of *statoscope*, the Richards Brothers have recently given a practical form to the air barometer—a most interesting instrument which has hitherto been known only to specialists and been confined to cabinets of physics.



THE STATOSCOPE.

The statoscope is an extremely sensitive metallic air barometer designed for registering the infinitesimal variations in the pressure of the atmosphere. It is very useful to know these minute variations, for, at a given moment, they may be capable of furnishing very important data as to storms. It is well known that during such phenomena the barometer shows a continual agitation. It rises suddenly, falls in a like manner, and we do not yet know the cause of these rapid jumps. It was formerly admitted that the barometer falls simply with bad weather; but as long ago as 1784, Rosenthal observed that when a storm is approaching the place where the barometer is situated, the mercury continues to rise up to the moment at which the storm cloud is at the zenith of the observer. As soon as the cloud has passed, the mercury falls. Since this observation the question has made little progress, direct observation being too tiresome and giving but few results. But the advent of registering apparatus and the increasing number of barometers of this kind has shown how great an interest these variations can be for meteorology. In order to study this phenomenon easily, it evidently requires instruments that greatly amplify it, both from the standpoint of the barometric oscillation and the length of the paper that receives the trace of it.

At first, there were constructed, at great expense, huge apparatus that wrote upon endless bands of paper, but for some useful observations made at quite long intervals, diagrams were obtained of an exaggerated length and in most cases without practical interest. A few years ago, some aeronauts requested of the Richards Brothers a very sensitive apparatus that should, when used in a balloon, show whether the latter was rising or descending, the observation of light paper thrown from the car not sufficing in most cases.

As the only thing to be measured in such a case is the atmospheric pressure, the answer to the request lay in the construction of a light and very sensitive barometer of slight bulk, that should require about one-hundredth of a millimeter of mercury. It was then that the Messrs. Richards constructed an instrument responding to all the desiderata of the question, and which they named the statoscope, in view of the purpose for which it was designed.

This apparatus they afterward rendered self-registering, and applied it to the taking of the curves of storms.

The instrument consists of a tight metallic air reservoir, of a capacity of four or five liters, which communicates with a pressure gauge having a registering diaphragm, the pen of which moves from 0·1 to 0·2 for a difference of pressure equivalent to $\frac{1}{15}$ of a millimeter of mercury. If we suppose that the temperature of the air of the reservoir is constant, the diaphragm of the gauge, being submitted on the one side to the pressure of the atmosphere and on the other to that of the air of the reservoir (constant), will show all the variations of the external atmosphere, with an amplification of from 10 to 20 times with respect to the mercurial column.

In order to keep the reservoir at a constant temperature, it is placed in the base of the box and covered with felt and wool. As the limit of the needle's travel is 5 millimeters of mercury (5 centimeters of displacement), more or less, of the pressure of the reservoir, it is necessary that the needle shall be easily brought back to zero. This operation is very easly effected by opening a cock that closes the air reservoir.

The statoscope is therefore a relative pressure barometer. It should be set in operation only at moments that one supposes to be interesting. To this effect, it suffices to close the cock and to note the absolute pressure at this instant. It thus constitutes, at slight expense, an accurate instrument that gives all the results required by meteorology.

Several important applications have already been made of this apparatus. Mr. Vallot took one to the summit of Mont Blanc, and has obtained extremely curious diagrams, during the snow storms that he has witnessed since the construction of his observatory.

Mr. Symons, the celebrated English meteorologist, has had a complete apparatus established, composed of a statoscope, an anemograph, and of various keys capable of being manipulated by hand so as to register upon the same band of paper the velocity of the wind in seconds, the indications of the barometer, the precise instant at which a lightning flash is seen, and that at which the noise of thunder is heard, and finally an estimate of the rain or hail that falls. This instrument, which he calls a *brontometer*, will permit of studying thoroughly and of throwing light upon that famous question of the curves of storms.

SIMPLE METHOD OF MEASURING HEIGHTS IN HASTY TOPOGRAPHICAL SURVEYS.

THE instruments designed for the approximate measurement of heights in hasty topographical surveys are capable of rendering services, but they are quite high priced and easily deviate from accuracy; so we believe that we shall do our readers a favor by showing them that it is possible to replace such apparatus very advantageously by a simple piece of section paper.

The information that we shall give is borrowed from an excellent work written by a learned traveler, Dr. Gustave le Bon. The author first shows how, by means of a single photograph, and without measuring the base, as has been necessary up to the present, it is possible, through the application of certain laws of perspective, to reconstruct the geometrical form of objects, with their dimensions. Then he treats of the methods of rapidly mapping the land surrounding the ruins of buildings. After describing various instruments, and giving the results of his experience, with the limits of their errors, he succeeds in proving that a common ten cent compass (such as is worn as a watch charm), fixed to a corner of a note book, is capable, in hasty surveys, of giving results as accurate as those of the best compasses of precision held in the hand. Any blank book whatever (an old journal, if need be), a ten cent compass, a piece of section paper and a pencil—that is all, according to him, that is necessary to make hasty surveys, comprising planimetry and leveling.

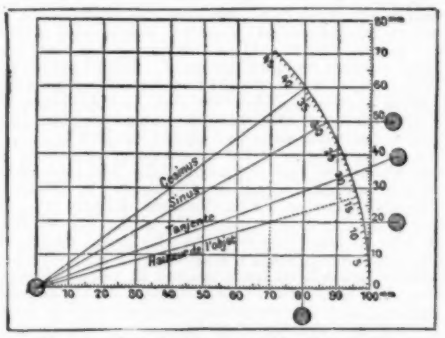


FIG. 1.—A SIMPLE GRAPHOMETER.

The graphometer (Fig. 1) consists simply of a piece of 0·08 by 0·1m. (3 by 4 inch) section paper divided into millimeter squares and fixed upon cardboard. To one of the angles of the paper is fixed a thread by means of a pin driven into the cardboard. The right hand

side of the paper and the bottom are divided into sections of 10 mm. (0·4 inch), and then with a protractor an arc of a circle of 0·1 m. (4 inch) radius is drawn and divided into degrees. This latter operation may be dispensed with, if, as is most frequently the case, one needs to calculate heights only. The graphometer would then be reduced simply to a sheet of section paper.

The instrument thus constructed gives the tangents, sines and cosines for all degrees from 0° to 45°. In order to obtain the same numbers as in a table of natural trigonometrical lines, it suffices to observe that the millimeters of the graphometer represent hundredths. The examples represented in the figure show the mode of operating. In order to make well understood the sometimes broken direction that the thread must follow in different cases, its movable extremity, like its fixed one, is represented as terminating in a shaded disk.

When glued to the inside of the front cover of a note book, this apparatus renders possible the measurement of vertical angles, while the compass fixed upon the same book permits of measuring horizontal ones. The compass thus completes it and permits of various topographical operations, which all reduce themselves in definitive to measurements of horizontal and vertical angles. In order to measure vertical angles, and consequently heights, with the graphometer, we have only to fix at the free extremity of the thread a weighty object, somewhat flat (say a cent with a hole in it), so that its thickness may not prevent the book from being closed. Then, at about 4 cm. (1·5 inch) from the pin, B, to which the thread is attached, another pin, A, is driven into the cardboard up to its head (Fig. 2). These two pins form a sight

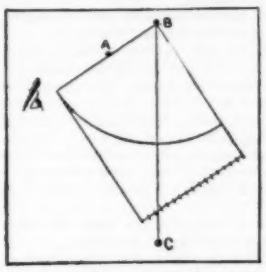


FIG. 2.—METHOD OF USING THE GRAPHOMETER.

line. The operation is performed as shown in Fig. 2. When the weight at the end of the thread has ceased its oscillations, it is held with the finger, and, the cardboard being turned up, we read, indicated by the thread, the vertical angle observed and its tangent. If the observation is made with care, it will be seen, upon repeating it several times, that the precision obtained is to within about a half degree, a figure that it is very difficult to obtain with the eclimeters fixed to the various systems of portable compasses. They, in fact, belong to a circle whose radius is at least three times shorter than that of the graphometer. The most frequent applications of this latter will be, in hasty surveys, to determine the height of a house, a tree, or a hill, the horizontal distance of which from the observer is known. The following examples will show the *modus operandi: Being 70 m. (230 feet) from a steeple, we see that the vertical angle of sight is 16 degrees, and we want to know the height of the steeple.* We bring the movable extremity of the thread over the 16°, place the point of a pencil under the thread at the level of the vertical line corresponding to the figure 70 read upon the lower scale of the graphometer, and then direct it toward the extremity of the horizontal line upon which the pencil rests. We find that it falls midway between the 20th and 21st millimeter of the vertical graduation, and we at once conclude that the height of the steeple is 20·5 m. (67·25 feet), plus the height of the observer's eye from the ground. The operation would be exactly the same in order to find the difference of level existing between two points of which the horizontal distance was known.

To Determine the Gradient of a Road and its Horizontal Projection.—The measurement of a slope is effected exactly as is that of the height of a house, but, as the eye of the observer is at a certain height, it is necessary to sight an object situated opposite one's self at the same level—the head of a guide, for example, who is walking at a distance of 20 or 30 m. (65·5 or 98·5 feet), or a tree trunk upon which a point has been marked at the height of the eye.

Knowing the gradient of a road, and the distance between two points ascertained by the number of paces, it is necessary to know also the horizontal projection of the road, since it is this only that is to be inscribed upon a map. The graphometer gives this at once. Let us suppose that, in a mountainous country, we have walked 80 m. (262·5 feet) over a path inclined 30 degrees; what is the horizontal length to be marked upon the map?

With a scale of which one of the extremities passes through the zero where the thread is attached and the other through the graduation 30°, let us measure 80 mm. (3 inches) upon the oblique line running from the 0° to 30°, and at the extremity of this length let us mark a point upon the graphometer with a pencil. The vertical line descending from this point indicates at the bottom of the graphometer the horizontal projection sought, say about 69 m. (226 feet).

Had we operated on 100 m. (328 feet), the process would have been simpler still, since we should have had only to read immediately upon the horizontal scale the cosine of 30°, say 86 m. (282 feet).

In all that precedes, it is, of course, a question of hasty surveys only, in which accuracy is necessarily sacrificed to rapidity. For accurate surveys Dr. Le Bon has devised instruments which are naturally more complicated than the preceding, but all easily portable, and a description of which will be found in his work.* Among these we may mention in particular his telestereometer—a small telescope about the diameter of the finger, the field of which is twenty-five times larger than that of ordinary telescopes, and which permits of measuring, not only distances, but angles also, with more precision than with the best graphometers.

The foregoing descriptions and engravings of the Spirograph, Barometer, Statoscope, and Measuring Heights are from our valued French contemporary *La Nature*.

* *Les Levers Photographiques.* Paris: Gauthier Villars et fils.

ATKINSON'S CYCLE GAS ENGINE.

AT the present time our attention is attracted by any device that promises to reduce the cost of producing power, or, to state it with greater accuracy, utilizes a larger percentage of the energy stored in coal. At the present time the gas engine leads, developing an indicated horse power from less than 1½ pounds of coal, results of one test showing 1·11 pounds per indicated horse power per hour, and that, too, in a 12 horse engine developing but 7 or 8 horse power. If such results

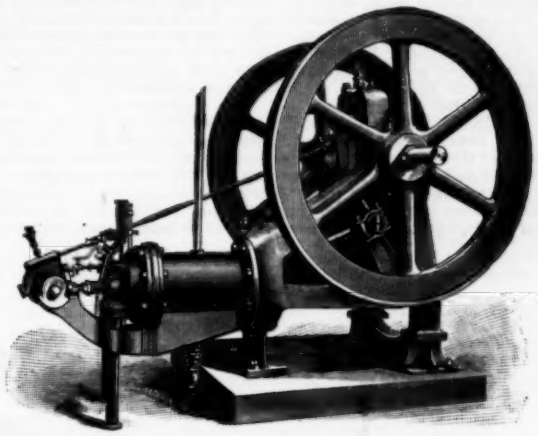


FIG. 1.—THE ATKINSON GAS ENGINE.

as these can be obtained in every-day practice, the gas engine is the coming motor. In this country its development has not progressed so rapidly as in Europe, and we are but beginning to realize that it is a more economical motor than the steam engine, and will eventally supersede it. It has been and still is generally regarded as a motor suitable only for small powers, but that the contrary is the case, and that large, powerful gas engines can be built, the mechanical world is just beginning to see. This being the case, those engaged or interested in the production of power should familiarize themselves with the history of the gas engine, with the principles controlling its operation, and with the mechanical devices adopted in the various engines that have, from time to time, been placed on the market; they would then be in position to judge intelligently of the relative merits of the surviving engines.

It is not our intention to give the history of the gas engine, but merely to call attention to the conditions necessary to obtain the greatest economy. Clerk in his work, "The Gas Engine," refers to a pamphlet published by Beau de Roches, in Paris, in 1862, and we quote: He states that to obtain economy with an explosion engine, four conditions are requisite:

1. The greatest possible cylinder volume with the least possible cooling surface. 2. The greatest possible rapidity of expansion 3. The greatest possible expansion. And 4. The greatest possible pressure at the commencement of the expansion.

In using boiler tubes, he states the efficiency of the heat transmitted increases with the reduction in the diameter of the tubes. In the case of engine cylinders, therefore, the loss of heat of explosion would be in inverse ratio to the diameter of the cylinders.

Therefore, he reasons, an arrangement which, for a given consumption of gas, gives cylinders of the greatest diameters will give the best economy, or least loss of heat to the cylinder. One cylinder only must be employed in such an engine; but loss of heat depends also upon time. Cooling, therefore, will be proportionately greater as the working speed is slower.

The sole arrangement capable of combining these conditions, he states, consists in using the largest possible cylinder and reducing the resistance of the gases to a minimum. This leads, he states, to the following series of operations:

1. Suction during an entire outstroke of the piston. 2. Compression during the following instroke. 3. Ignition at the dead point and expansion during the third stroke. 4. Forcing out of the burned gases from the cylinder on the fourth and last return stroke.

The ignition he proposes to accomplish by the increase of temperature due to compression. This he expects to do by compressing to one-fourth of the original volume.

The only successful engines that have been placed on the market are those embodying the above cycle. All others have had but a short life and have disappeared. Some of these have been resurrected under different names, only to repeat the same history.

In designing an engine to meet the conditions laid down above, the first may be provided for by careful designing, and the second by high piston speed; this being limited by the time necessary for complete combustion. But the difficulty begins with the third, as the greatest possible expansion can only be obtained by expanding the charge to a volume greater than the original volume; for when expanded to the original volume only, the charge will have a high terminal pressure, and if expansion is only carried to this point, the products of combustion will be discharged with a large amount of energy not utilized.

The difficulty also continues with the fourth, as the purer the mixture, the higher will be the pressure at the commencement of the expansion, and in an engine in which the four strokes are of equal length, it is impossible to obtain a pure mixture, owing to the fact that the necessary compression space is, after the exhaust stroke, left full of the products of combustion, and these, of course, adulterate the charge and reduce the pressure. There is also another disadvantage attending the use of such a compression space, and that is that it places a limit upon the size of the engine; for if an engine of large power is built, the cooling surface of the cylinder will bear such a small ratio to the volume of the cylinder that the percentage of heat lost to the surfaces by the products of combustion during the exhaust, suction, and compression strokes will be very small, and the temperature of the charge will be so high that when the heat due to compression is added, a premature explosion will take place, and the

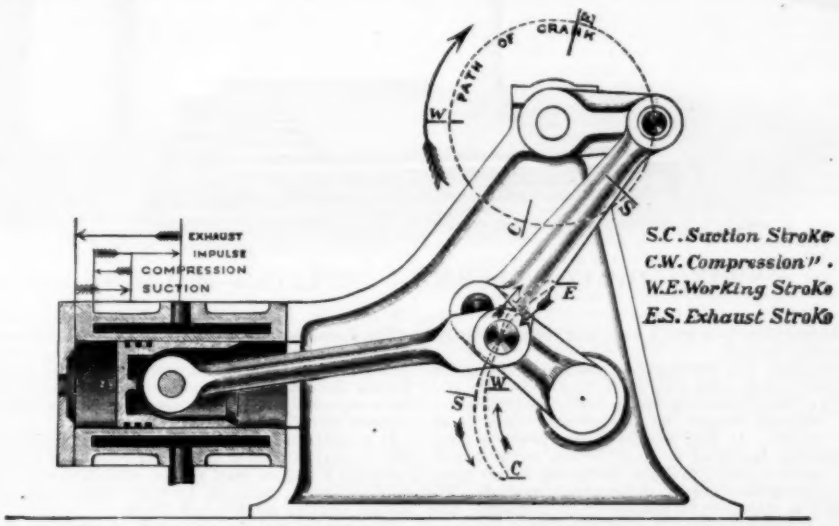


FIG. 2.—LONGITUDINAL SECTION OF THE ATKINSON GAS ENGINE.

motion of the engine be retarded or reversed. Consequently, to increase the power of engines after certain power has been reached, one or more cylinders have been added, forming, in reality, separate and distinct engines connected to one crank shaft.

A new engine has, however, appeared which not only overcomes the difficulties presented by the third and fourth conditions, but also the latter trouble; and, in order to emphasize the statement that it approaches more nearly than any other the ideal engine, we would call attention to De Roches' cycle as followed in engines of the Otto type.

During the suction stroke the charge is drawn in and mixes with the products of combustion. The next stroke compresses it, ignition then takes place, and it is expanded to the original volume only, and the terminal pressure is high. The products of combustion are then expelled by the fourth stroke.

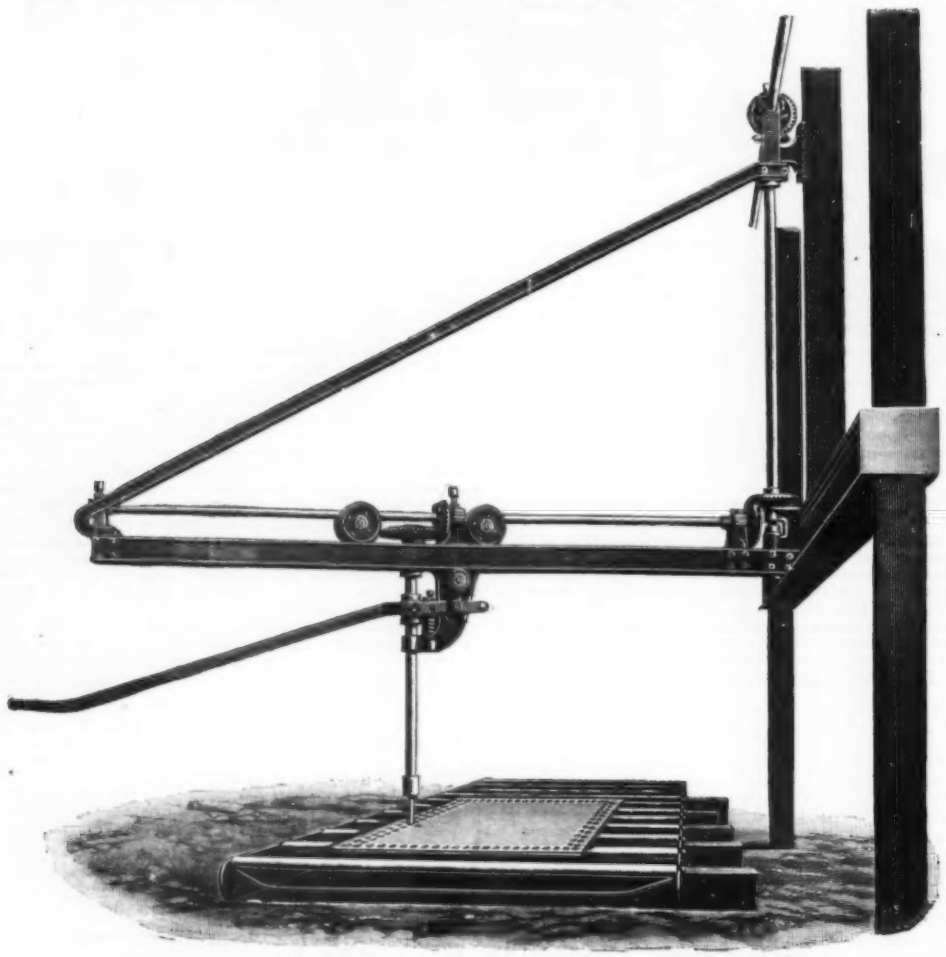
The new engine referred to—Atkinson's Cycle Gas Engine—performs all these operations in one revolution of the crank shaft. Fig. 1 is a perspective view of the

engine, and Fig. 2 a sectional elevation, showing only the mechanism by which the above operations are effected. It will be noticed that the different operations are obtained by the addition of but two parts—a link, which vibrates through the arc of a circle, and a connecting rod, and by changing the position of the crank shaft in relation to the cylinder. The outer end of the piston connecting rod is attached to a pin passing through the crank connecting rod, and the latter is connected to the link. The different centers are so placed in relation to each other and to the center line of the cylinder that the center of the pin to which the piston connecting rod is attached travels in a curve resembling the figure eight, passing over the portion S E during the suction stroke, over C W during the compression stroke, over W E during the working stroke, and over E S during the exhaust stroke. The figure shows that the compression stroke is shorter than the suction stroke, that the working stroke is almost double the suction stroke, that the exhaust stroke ends with the piston as close to the cylinder cover as it is possible mechanically to have it, and that the working stroke takes place in one-quarter of a revolution. It is apparent that, with a given rotative speed, greater rapidity of expansion can be obtained with this engine than with engines of other types, and that it is possible to expand the charge to such a volume that the terminal pressure will be reduced to the lowest practical point, and that, owing, to the purity of the charge, the greatest possible pressure will be attained at the commencement of the expansion. Owing to the fact that practically all the products of combustion are expelled, the incoming charge will attain no higher temperature in a large engine than in a small one, and, consequently, large sizes can be built.

This, certainly, is a remarkable piece of mechanism to accomplish such results by such simple means; and the results of tests made by disinterested parties show that the friction cannot be any greater than in an ordinary engine. If this engine should prove a commercial success, operated in conjunction with a producer for making cheap fuel gas, there can be no question as to its superseding all other prime motors. We understand it has proved successful in England, and is now being manufactured in this country.

SWING JIB COUNTERSINK DRILLING MACHINE

THE great size of shell plates now worked into the hulls of large steamers, and their consequent weight, has called forth several adaptations of machine tools, so as to reduce the manipulation of the heavy plate as much as possible. Our illustration shows a swing jib countersinking drilling machine which secures this advantage. This machine, constructed by Messrs. Jones, Burton & Co., 19 Castle Street, Liverpool, can countersink all the holes in a plate 16 ft. by 5 ft., without any movement of the plate. As the illustration shows, the drill spindle may be moved laterally on a swinging jib attached to the wall or columns, and the workman in charge may alter the position of the spindle by a lever for the feed. The spindle is of steel 2⅛ in. in diameter, running in a gun metal bush. It is powerfully geared and driven by fast and loose pulleys 16 in. in diameter by 4¼ in. face. The total weight is 21 cwt. For longer plates two machines may be placed 16 ft. apart, thus covering an area of 32 ft. by 5 ft. At present the space needed for a machine to drill a 16 ft. plate is double, to allow the plate to pass in and out of the machine. The machine is in use in many shipbuilding yards.—*Engineering.*



SWING JIB COUNTERSINK DRILLING MACHINE.

PEARY'S GREENLAND TRIP.

By R. E. PEARY, U.S.N.

IT was the writer's desire that his simple and unpretentious project for the determination of the northern terminus of Greenland should be allowed to materialize, and the party to start quietly and without notice beyond the circle of those immediately interested. After the return of the party, if successful, would have seemed an appropriate time for general notice. The publicity given the matter, though it has largely increased my work in attending to a host of correspondents, comprising friends, scientific men, applicants for positions on the expedition, enthusiasts, cranks, and others, has had advantages, in that it has brought to my attention special items of supplies and equipment of recent production which otherwise I should not have known of, and which may be of much value. It has also made me acquainted with men whom it is a pleasure and an honor to know.

The widespread and entirely unexpected popular interest in my project has made it seem appropriate that I should comply with the request to take the public into my confidence, and tell details of interest, of my project and preparations. My project and theory are very simple, and can be stated briefly.

My party of six will be landed in June or early in July at Whale Sound, latitude 77° 30' north.

The house will be erected at once, and the remainder of this season will be devoted to hunting for the winter's supply of meat, examining the features of the Whale Sound region, collecting natural objects, and more especially to reconnoissances of the inland ice in various directions.

It is anticipated that one of these reconnoissances will be carried across the great tongue of the inland ice covering Prudhoe land to the southern angle of Humboldt Glacier, and an advance depot for the main sledge journey established there.

The winter will be occupied in making and fitting sledges, clothing, and all traveling equipment, and in snowshoe and skier practice, for which the level surface of Inglefield Gulf (head of Whale Sound) is especially adapted.

Early next spring four or five of the party will start over the inland ice to Humboldt Glacier, with full sledges and dogs if practicable. Should favorable advance be made, this party will continue on from Humboldt Glacier to the head of Petermann Fjord. Here a second depot of supplies will be deposited, and from this point the advance party of two or three will push on with full sledges, the others returning to Whale Sound, to devote their time during the absence of the main party to meteorological observations, collecting and surveying.

The main party will proceed from the head of Petermann Fjord to the head of Sherard Osborne Fjord, establish a depot there, thence to the head of De Long Fjord, establish a depot there, thence to the northern terminus.

This point reached and determined, the main party will retrace its steps to Whale Sound, taking up the various depots, and the entire party will then seize the first opportunity to come out.

The salient features of the project are the smallness of the party and the utilization of the great interior ice plateau, the imperial highway of inner Greenland, as a road, instead of the sea of ice, and the whole theory of the project rests upon the now well established fact that the interior of south and middle Greenland is covered with an uninterrupted ice cap, and the more than probability (in my opinion) that in north Greenland the conditions are the same, and the ice cap nearly, if not quite, coextensive with the land.

I recognize the fact that there are many ways in which the reality may vary from the above, and feel that when the elaborate and scientific theories of such eminent men as Dr. Petermann and Baron Nordenskjold, as to conditions in the Arctic beyond the horizon of actual exploration, have been shown by subsequent exploration to be entirely erroneous, it is more than nonsense for a novice to predict what he will or will not find.

My personal impression is that the northern terminus of Greenland is not north of the 85° parallel of latitude, and that the inner ice cap is practically coextensive with the land; and this opinion is shared by Judge Daly and, I think, by most other eminent geographers.

But whether this is the case, or whether Greenland extends as an Arctic continent across the pole, or is connected more or less loosely by detached masses of land with Franz Josef Land, or whether the ice cap ends at about the 82d parallel, as in Grinnell Land, I feel confident that in any contingency the efforts of my party will result in discoveries of interest, and, I hope, of considerable value to the scientific world.

Should the Greenland ice cap terminate at or south of the 82d parallel, as Gen. Greely believes, I shall endeavor to follow its edge to the unknown east coast above Cape Bismarck.

The especial advantages of my overland route over all others I regard to be as follows:

The possibility of laying a straight course from point to point, with the certainty that no tidal crack or chaos of heaped-up ice will compel a long detour, or stop all further advance; that every foot traveled is a foot advanced, and the comforting assurance that nothing can happen to cut off the retreat.

The even and unvarying character of the surface to be traversed, and the gain in lightness of sledges and equipment and rapidity of advance resulting therefrom.

The length of season (at least six months) during which sledging may be prosecuted.

The facilities that the "nunataks" or island mountain tops, which project above the "inland ice" at distances varying from two or three to forty miles from the edge of the ice, offer for forming depots of provisions.

Depots placed on these "nunataks" are safe from the attacks of bears or other animals, and the "nunatak" itself forms a prominent landmark by which to recover the depot.

The exceptional value of the elevation of the route in accurately charting the coast and detecting the existence of more northerly land or lands. From the heights of the ice cap, with miles of the coast lying like a map below, it can be charted with an accuracy and rapidity unknown to one toiling from headland to headland along the seashore.

My base is the one advocated by Kane, Hayes, Hall, Judge Daly, and almost every American Arctic authority; a region having a small and kindly native population, abounding in game, and within easy reach of the whalers which pass Cape York every year on their way to the fishing grounds in Lancaster Sound and adjacent waters.

My proposed line of advance is absolutely direct throughout each stage. If it were not desirable to touch at the heads of Petermann, Sherard Osborne, and the other principal fjords which interrupt the northern coast, and determine their length and the characteristics of their heads, the line of march might follow very closely a great circle course from the head of Whale Sound to beyond Lockwood's "farthest."

As to the dangers and hardships of an eighteen months' sojourn above the 77th parallel, sentiment and imagination aside, I believe them to be no greater than they would be in northern Norway, Siberia, the higher Alps, or, to come nearer home, in Montana or Dakota in winter.

It may be news to many to know that there are now in Greenland, under climatic conditions and environment similar to those of my proposed headquarters, Danish officers with their wives and families, living the same home life as the better classes here, with their window gardens, their music, their books, and all the other accessories of culture.

Judge Daly, the distinguished president of the American Geographical Society, who has been actively interested in and intimately associated with every American Arctic expedition from Kane's to the present one, says:

"Peary's plan of exploration, which he has made known to me in writing, is a very judicious one, and, if carried out as he proposes, will in all probability be successful.

"An exploration of the Arctic for the purpose merely of reaching the North Pole is undertaking the accomplishment of simply a geographical feat; but an exploration of the Arctic in its entirety is something of practical importance, for until we know more than we do now of what takes place in the movement of the air and of the water in the Arctic, we shall not acquire what we ought to know of the laws of aerial and oceanic currents, a knowledge of great importance for navigation as well as for other purposes.

"An essential part of this knowledge is the form and direction of northern Greenland. The late distinguished German geographer, Petermann, was of the opinion that Greenland was a continent that stretched across the whole of the Arctics, but I have never been satisfied with his reasons. My own impression has been that the Arctic is an archipelago of islands, and that Greenland is one, terminating not much further north than the farthest point reached by our own explorers; and Peary's projected exploration, from the direction he intends to take and the manner in which he proposes to conduct it, will, I think, settle that question, an important one in respect to the mass of waters in the Arctic and their movement and direction in connection with the motion of the earth."

I shall endeavor to collect all scientific material

and make all observations practicable, but my first and last object will be the attainment and determination of the northern terminus of Greenland, and everything will be subservient to that.

THE MEMBERS OF THE PARTY.

I shall be accompanied by five young men, and the following particulars about the members of the party may be of interest:

John M. Verhoeff, of Louisville, Ky., is a young man of 25, educated in a Eastern university, a mineralogist, and, though somewhat below the average in stature, has a magnificent lung development and a record for endurance and cross country walking. Mr. Verhoeff has contributed generously to the expenses of the expedition.

Dr. Frederick A. Cook, the surgeon of the expedition, is an able young physician and surgeon, a native of New York State, a graduate of the College of Physicians and Surgeons, and of the University of the City of New York, and has been in practice in New York City for several years. He is 26 years old, strongly built, height 5 feet 9 inches, weight 150 pounds, lung expansion 5 inches.

Langdon Gibson, of Flushing, L. I., is a stalwart young fellow of 26, and one of the many active and enthusiastic members of the American Ornithologists' Union. He was one of the Brown-Stanton party in the memorable Colorado Cañon survey of 1889–90, and knows what arduous work is. He is six feet tall, weighs 178 pounds, and has an exceptionally fine lung development.

Eivind Astrup, of Christiania, Norway, is a stalwart young fellow, who has but recently come to this country. He is the son of the commander of the Royal Civil Guard of Christiania, a first-class graduate of the Christiania Commercial College, and a winner of numerous prizes in athletic sports, especially ski-running. He is 5 feet 7 inches in height, weighs 167 pounds, and has a lung expansion of 4 inches.

Matthew Henson is a hardy young colored man, a native of Virginia, 23 years old. His intelligence and faithfulness, combined with more than average pluck and endurance, as shown during several years that he has been with me through varying experiences, part of the time in Nicaraguan jungles, lead me to regard him as a valuable member of the party.

The members of my party are all young, and in addition to possessing first class physique and perfect health, they are men of education and attainments. I believe this to be the type of man best fitted to endure with minimum effect the ordeal of the Arctic winter, and to effectively execute a two or three months' dash on sledges, where intelligent will power, elasticity and enthusiasm are at a premium over the stolid endurance of muscles hardened by years of work.

Mrs. Peary will accompany the party to Whale Sound. Possessed of youth, health, energy, and enthusiastic interest in the work, she sees no reason why she cannot endure conditions and environment similar to those in which Danish wives in Greenland pass years of their life. In this opinion I fully concur, and believe that in many ways her presence and assistance will contribute to the valuable results of the expedition, as they have been invaluable to me in the preparation.

FOOD SUPPLIES OF THE EXPEDITION.

The food supply of the party is not materially different from that of the later Arctic expeditions. Tea, coffee, sugar, and milk are in quantity sufficient to last two and a half years; other supplies for a year and a half. But little meat will be taken outside of the pemmican for the sledge journey, as there is an abundance of reindeer, ptarmigan, Arctic hares, foxes, ducks loons, seals, and walrus in and about Whale Sound.

Special items of interest, principally for the sledge journey, are as follows: Tea, compressed into one-fourth pound cakes, partially divided, like chocolate, into one-fourth ounce squares. Each square, when broken off and crumbled up, will make a generous cup of tea. This tea was obtained from London through the kindness of Mr. B. F. Stevens, so well known to navy men.

Compressed pea soup tablets, a German preparation. Each tablet contains pea meal, bouillon extract, and seasoning, and, when crumbled and stirred into boiling water, will make a quart of nutritious and palatable soup.

Beef meal pemmican and beef meal and cocoa tablets, prepared expressly for the expedition. Both of these preparations are experimental, but there seems every reason to believe that they may prove a valuable addition to the menu of Arctic sledge parties. The beef cocoa tablets, it is anticipated, will be valuable as a lunch while marching, when it is not desirable to halt for a regular meal.

Evaporated cabbage, potatoes, onions, turnips, and carrots have been prepared expressly for the expedition. Evaporated apples and potatoes will form part of the daily bill of fare. The items marked* in the following provision list are all packed in rectangular sealed tins, containing twenty-five pounds net each, and two tins are packed in a close box. The gross weight of each box does not exceed seventy pounds, and every box and package is stenciled with its contents. Here is the provision list:

Tea*, coffee*, sugar*, condensed milk, hard bread*, corn meal*, rice*, hominy*, lard, pemmican, breakfast bacon, canned corned beef, salmon, baked beans, canned corn, canned peas, evaporated apples*, potatoes*, cabbage*, onions*, turnips*, and carrots*, canned tomatoes, assorted fruits, maple sugar, cranberry jam, compressed pea soup*, salt, chocolate, cocoa, corn starch, pickles, raisins, vinegar, pepper, ginger, mustard, cloves, cinnamon, nutmeg, lemon extract, vanilla extract, Worcestershire sauce, ketchup, hops, lime juice, yeast powder, Liebig extract, plum pudding, extract of coffee, beef meal pemmican, beef meal and cocoa tablets.

The sledge ration, unless experience suggests a modification, will consist of pemmican, cranberry jam, hard bread, pea soup, tea, and condensed milk.

THE HOUSE TO BE BUILT AT WHALE SOUND.

Next to the food supply comes the house. This will be a light 12×20 structure (inside measurement), with double walls inclosing a ten inch air space. There will be a triangular air space between the ceiling of the rooms and the roof sheathing, and the rooms will have three layers of tarred paper between them and the exterior air. The walls of the rooms will be hung at first with blankets, and later probably with skins.

The house will be surrounded by a wall of stones, turf, and snow as high as the eaves, leaving a narrow passage entirely around the house, and during the winter this space and the roof of the house itself will be covered in with a thick layer of snow.

THE EQUIPMENT.

The expedition will have two whale boats, built expressly for it, and supposed to be the best that can be made.

One of these, built by S. H. Mitchell, of New Bedford, is 28 feet long, 6 feet beam, and 28 inches deep amidships. This boat weighs 800 pounds, and carries one sprit sail and a large jib. The other, built by Reeves & Comstock, of New London, Conn., is 28 feet long, 6 feet beam, and 24 inches deep, and weighs 600 pounds. It has two masts, sliding gunter rig, and a jib. Both boats have white cedar planking and white oak frames and knees, and are fitted with steel keel shoes, and sleeping cuddies, and each has a rudder and tiller, a steering oar, five pulling oars, and a grapnel.

One of these boats has been named the Mary Peary, after the mother to whom I owe so much, whose prayers, if earnest human appeals have power to influence the Infinite, will bring the expedition back successful.

The other has been named the Faith, after the sturdy boat which thirty-six years ago brought Dr. Kane and his brave companions back to friends and civilization, past the same cliffs and bays that will know this new Faith. There will be several sledges, including the two made and used by me in Greenland in 1886. The new ones, though of the same type, will be lighter than the old ones.

Each member of the party will have Indian snowshoes and Norwegian "ski" moccasins and rubber ice creepers. The alcohol stoves will be very light, with asbestos jacketed boilers. The sleeping bags will be of elk skin. All special clothing taken from here will be woolen, fur clothing to be obtained at Whale Sound.

Special items are heavy grades of hygienic underwear, blanket combination suits, blanket and knit mittens and socks, blanket coats with hoods, knit hoods, and heavy knit stockings.

Each member of the party will have a Winchester 44 caliber repeating carbine and a hunting knife. There will be also a Winchester 45 caliber repeating rifle, a Winchester repeating shotgun, 10 gauge; a Daly three-barrel gun, shot barrels 10 gauge, rifle barrel, 45 caliber, and Colt's frontier revolvers.

The Winchester and Daly shotguns take the same shell, the 45 caliber Winchester and the Daly rifle barrel take the same cartridge, and the Winchester carbines and Colt's revolvers use the same cartridges.

The other articles of my equipment are as follows:

THE SURVEYING OUTFIT.

This comprises one traveler's theodolite, arranged expressly for the work, by Pauth & Co., with prismatic eyepiece, colored glasses, striding level, and 6½ inch vertical circle, reaching to 10 seconds.

One sextant, 7 inch, with artificial horizon and extra mercury.

One pocket sextant.

Three pocket half chronometers, made for the expedition by the Howard Watch Company.

One prismatic compass.

One sledge compass.

Seven pocket compasses.

Three aneroids, reaching to 12,000 feet.

One aneroid, reaching to 8,000 feet.

One aneroid, reaching to 3,000 feet.

One Henderson's self-registering pocket thermobarometer, by Queen & Co., with set of extra thermometers by Green.

One one-hundred foot steel tape.

Two fifty-foot steel tapes.

Three odometers.

One field glass.

Two spy glasses.

One deep sea thermometer.

METEOROLOGICAL OUTFIT.

One observatory barometer, Green, No. 2.

One hygrometer.

Four sets maximum and minimum thermometers.

Six special minimum thermometers graduated to — 68° F.

Two special minimum thermometers graduated to — 80° F.

Six mercurial thermometers.

One anemometer.

The photographic outfit consists of three Kodaks, No. 4, 4 by 5, made for the expedition, and 2,000 films.

MISCELLANEOUS ARTICLES.

Oil stoves.

Japanese kiros.

Navy blue lights and signals.

Rockets.

Burning glasses, flint and steel, pocket lamps, and many other articles too insignificant to mention, yet of importance in a region where not even a piece of string or a paper of pins can be obtained.

THE VOYAGE TO WHALE SOUND.

The party will go from New York to Whale Sound in the steamer Kite, owned by Bowring Bros., of St. Johns, N. F. She will leave New York with the expedition on or about June 6. The Kite is a barkentine rigged vessel, built for a whaler but used principally as a sealer. She can steam 7½ knots, and has been thoroughly overhauled and additional cabin accommodations put into her for the party.

She is a stanch, strong vessel, and is considered especially adapted for the voyage. After the North Greenland party is landed at Whale Sound she will be taken in charge by Prof. Heilprin, of the Philadelphia Academy scientific expedition, for a two months' scientific cruise in Arctic waters.

Although it is impossible to mention all to whom I am under obligations for courtesies and encouragement, I cannot omit to mention some to whom I am especially indebted.

To Profs. Lee and Young and the president and other members of the faculty of Bowdoin College, my alma mater, to Prof. F. W. Putnam, of the American Association for the Advancement of Science, to Judge Daly, to President Adams and the Executive Committee of the Geographical Department of the Brooklyn Institute, to the late distinguished President Leidy, and the Council of the Academy of National Sciences, of Philadelphia, I am indebted for cordial and most valuable indorsement of my project.

To Secretary Tracy I am indebted for my leave, for his approval of my project, and for his kindly interest in my plans; and to Commodore Farquhar and Chief Engineer Melville, chiefs respectively of the Bureaus of Yards and Docks and Steam Engineering, for kindly offices which no others were in a position to render so effectively.

To the National Geographical Society I am under obligations for its interest in my work, and to the society and Miss Ulrica Dahlgren for a beautiful flag, to be carried to the "farthest."

Though friends in the Portland Society of Natural History and others have accompanied their wishes for success with tangible inclosures, it is to the American Geographical Society, and particularly to the efforts of the active, enthusiastic members of the North Greenland Committee of the Philadelphia Academy of Natural Sciences, Profs. Leidy, Sharp, Heilprin, and Brinton, Mr. Hart, and Drs. Ruschenberger and McCook, that I am indebted for the sinews of war necessary, in addition to my own resources, to fit out my expedition.

And when the unlooked-for point blank refusal of the Dundee whaling companies and the director of the Greenland trade to give my party transportation to Greenland in any of their vessels, on any terms, made it necessary to charter a vessel for the purpose, Prof. Putnam, in behalf of his Department of Ethnography of the World's Fair; Mr. Verhoeff, and the organization by the Philadelphia Academy of a party of scientific men to make an extended scientific cruise, assured the additional funds necessary to meet the more than doubled expense.

To the press of the country I am indebted for its exceptionally friendly attitude toward my project. This fact has been as pleasant to me as it has been entirely unexpected.

The expedition sailed from New York June 7.—*N. Y. Sun.*

ANOTHER ARCTIC EXPEDITION.

On June 7, less than twenty-four hours after Lieut. Peary started north to ascertain, if possible, the northern extension of Greenland, another expedition set out for the great island, expecting to spend this year and next in investigations upon the east coast. This second expedition is that of Lieut. Ryder, who intends to explore the unknown coast between 66° and 70° north latitude. The expedition left Copenhagen under the auspices of the Danish government. If Ryder reaches this coast through the ice which presses against it, he intends to connect the surveys of Scoresby and the Koldewey expedition on the north with the discoveries of Capt. Holm on the south, and thus complete the outlining of the east coast of Greenland from Cape Farewell, its southern extremity, to Cape Bismarck, in the far north.

Like Peary, Ryder believes in the efficacy of small exploring parties in the Arctic regions. He is accompanied by only five or six men. He hopes to devote a considerable part of next fall to the study of glacial phenomena, and after he has established his camp at Cape Stewart he will investigate the neighboring fiords with their glaciers. As soon as the sledging period begins next spring he will start south with sledges and boats, hoping both to ascertain the outlines of the coast and to study the edge of the inland ice. He will travel south as far as Angmagsalik, where he will await the arrival of a steamer to take him back home. It is the purpose to have the vessel attain the coast at two points, if possible; first going to Cape Stewart to take on board the collections which the party make during next winter and this summer's campaign, and secondly, pushing through the ice again to take the explorers on board at Angmagsalik.

If for any cause the vessel does not reach Ryder and his men, he will be compelled to spend another winter in the far north, living this time among the natives, whom Capt. Holm has already so carefully studied. In this event he will in the following spring retreat to Cape Farewell and the Danish settlements of the west coast in the boats which he expects to take with him from Cape Stewart to Angmagsalik.

These two expeditions, with the auxiliary exploring party which is accompanying Peary for the purpose of making scientific collections on the west coast and ascertaining the coast outline of Melville Bay, are the only enterprises of importance which are likely to attract attention in Greenland during the next two or three years. The success of all these expeditions is problematical. The Peary auxiliary party will, without doubt, succeed in making valuable observations and gathering important collections, but it is very doubtful that they will be able to get within sight of the coast of Melville Bay. If Ryder and Peary succeed in their ambitions, we will know at last practically all there is to ascertain about the coast line of Greenland, except along Melville Bay and the stretch between Cape Bismarck on the east coast and the eastern limit of Peary's travels. Whatever occurs, we shall be likely to have a good deal of interesting news from the Arctic regions within the next twenty months.—*N. Y. Sun.*

ANIMAL LIFE ON A CORAL REEF.*

IN nearly all the shallow waters of the tropical seas there is an abundant fauna, but nowhere is there such a crowd of marine animals of all kinds as there is in the region that extends from the growing edge of the coral reef to a depth of some 10 or 15 fathoms beyond it. This may be due to the fact that in this region there is plenty of light and heat, no great or sudden changes of temperature, or of the chemical composition of the water, and there is an abundant food supply brought by tidal currents from the surface of the ocean. Here it is, then, that we find the richest fauna. Here it is that the struggle for existence is most severe, and here it is that the animals are protected and concealed by the most pronounced marks and colors, and provided by nature with various forms of

* Abstract of lecture by Dr. S. J. Hickson, delivered at the London Institution, January 22, 1891.—*Nature.*

armor, stings and spines to defend them in the battles with their enemies.

One of the most interesting results of this severe struggle for existence, or perhaps it would be more correct to say of the large number of species competing for existence, is the important faunistic difference that may be observed between one reef and another—nay indeed, between one part of a reef and another part of the same reef.

Darwin long ago pointed out that in the struggle for existence a very slight advantage gained by any one of the competing species may entirely alter the whole aspect of the field; and it follows that a very slight though constant difference in the physical conditions, such, for example, in the case of coral reefs, as rapidity of tidal currents, amount of surf or character of the shore rocks, may completely change the characteristics of the fauna. There are, it is true, some genera and species that are apparently found on all the reefs, such as Tubipora and Madrepora, but every reef has its own peculiar characters, and a naturalist never feels when he is examining one that he has seen something exactly like it on any previous occasion.

The majority of the corals that are found on the reefs of North Celebes belong to two great orders—the Zoantharia and Alcyonaria. The prevailing color of the living Zoantharia is dull greeny brown. The tentacles and the oral disks, and in some cases the growing or younger branches as a whole, may be very brightly colored. White, pink, emerald green, violet, and blue, are colors frequently met with in different parts of the Zoantharian colony. The colors of the Alcyonarians may be due to the bright red, yellow, or purple spicules or to the rich brown or green color of the soft parts. There is very considerable variation in the color of the soft parts of the Alcyonaria. The tentacles of the polyps of Tubipora, for example, may be any shade between bright green and pinkish brown. A species of Sarcophytum, again, common on the shores of Celebes, showed green and greenish yellow and yellow examples within the same half mile of reef. All of these coral colors, with the exception of the color of the spicules mentioned above, are soluble in spirit, the soft parts becoming, after prolonged immersion in this fluid, pale brown. The alcohol extracts of a considerable number of corals have now been submitted to spectrum analysis, and the bands they exhibit show close affinities with vegetable chlorophyl.

There is no experimental evidence at present that proves that the colors of the corals, nor indeed of the sponges, are either protective or warning in function.

It seems much more probable that these brilliant colors represent different stages in the building up or breaking down of some complex chemical substance that is always present in marine zoophytes, and performs some important physiological function.

Besides the numerous sponges, corals, holothurians, mollusks, etc., that are attached to the bottom or creep but slowly from place to place, the numerous species of swimming animals that are capable of active movements in pursuit of prey or escaping from their enemies must be considered as part of the fauna of the coral reef. These include fishes, cephalopods, and crustacea, and those of them that seem to live habitually among the corals of the reef are characterized by the possession of very curious spots or stripes and very brilliant colors.

Soon after my arrival in Talisse a large lobster was brought to me marked by broad transverse bands of blue and white; a large squilla is not uncommon marked with similar bands of white and deep purple, and the little prawn *Stenopus hispidus*, that I found in a tidal pool close to a reef, has bands of red and white. The cephalopods have also peculiar markings. One specimen that I found, *Octopus lunulatus*, had large blue spots over its body and arms. The fishes again are marked with spots and stripes of various kinds and many brilliant colors.

Without going too deeply into the argument, we are justified in saying that these animals are so marked and colored because they live among the brilliant surroundings of the coral reef; or to put it in another way animals similarly organized and of similar habits would be at a disadvantage on the coral reefs if they were not so marked and colored. The other fishes of the tropics do not possess these curious and beautiful characters; the sharks, bonitos, flying fishes, herrings and others that do not live habitually on the coral reefs are not unlike in general color and ornamentation the fish of temperate seas. Again, the crustacea and fish of the tropical rivers and lakes are not as a rule characterized by any peculiar coloring or marking. These peculiarities, then, are not directly due to the high temperature and bright light of the tropics, but they are due to the character of the surroundings.

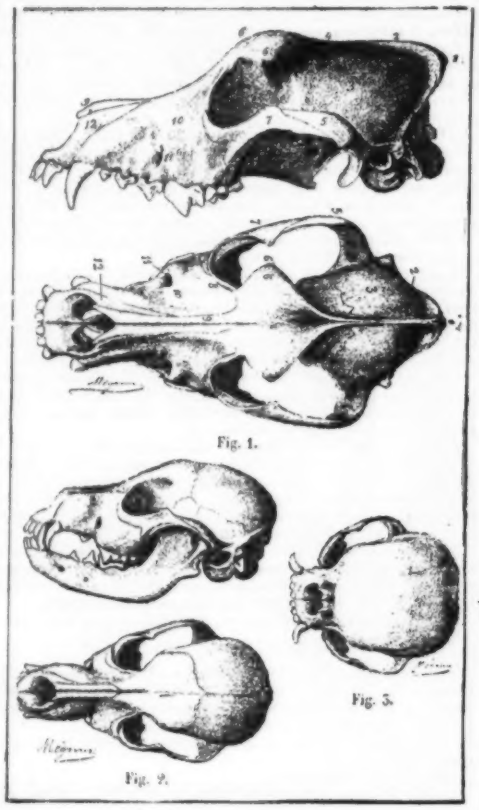
Most of the colors must be considered to be concealment colors. *Stenopus hispidus*, though so very conspicuous when taken out of the water, was extremely difficult to see in the pool where I found it. I should, in all probability, have failed to notice it, had I not quite unintentionally and blindly touched it with my stick. Like all animals protected by concealment colors, it remained perfectly motionless when alarmed. When looking down on to the growing edge of a reef from a boat on a calm day, it is very difficult at first to see anything but the corals and sponges. After a time, when the eyes become more accustomed to the light, the fish may be distinguished. Those that are colored blue are much less readily seen than the gold, yellow, and red varieties; but an examination of the fish that I caught myself, and were caught for me by the natives, showed that the fish in which blue is the prevailing color are much more frequent in the very shallow water, while those that were caught in water from 15 to 20 fathoms were more frequently red or yellow. The blue color seems to be a protection for the fish from air-breathing enemies—the eagles, ospreys, and hawks; and as these enemies can only approach them from above, the colors are frequently confined to the dorsal sides. The red and yellow colors of the fish seem to be a protection from animals, such as the sharks, perch, and other carnivorous fish, that approach them from the deeper waters beyond the reefs. Thus red and yellow fishes rarely have these colors confined to the upper sides, and many of the blue fishes are colored red or yellow ventrally.

It is difficult to frame any general rule to account for the curious distribution of the colors of these animals in spots and stripes. Speaking in very general terms, for there are many exceptions, the fish that browse on the corals, possessing small mouths and chisel-shaped teeth (such as the chætodons, trigger fish, and surgeons), are striped; those that feed on other fish, and have large mouths armed with carnivorous teeth, such as the Serranidæ, are spotted.

The only example of what appears to be a warning color that I have noticed occurs in connection with the spines on the tails of certain surgeons and trigger fish. *Acanthurus achillis*, for example, has a uniform purple color, but there is a bright red patch surrounding the formidable tail spines that give these fish the name of surgeons. Similar warning colors are very pronounced also in *Naseus unicornis* and *Naseus lituratus*, and in some of the Balistidæ.

THE BREEDS OF DOGS.*

IN our preceding articles we have shown that our shepherd's dogs, our watch dogs, our harriers and our hunting dogs are descended more or less directly from



FIGS. 1, 2, AND 3.—CRANIA OF DOGS.

Fig. 1.—Cranium of an adult French spaniel. Fig. 2.—Cranium of a two months' old spaniel. Fig. 3.—Cranium of a dwarf Japanese dog.

three specific types, the existence of which is demonstrated by fossil remains and the most ancient historic monuments.

As regards the small house dogs we find no information as to their ancestry, either in paleontology or ancient monuments, and this proves that they are a product of domestication. In fact, such domestication already dated back several thousand years when the existence of small house dogs was first mentioned. The most ancient information in this regard is due to Strabo. This Greek geographer, who lived in the last century before our era, somewhere says: "There is a Sicilian city named Melita, whence are exported very beautiful and well proportioned dwarf dogs, which are called *canes melitei*." It is thought that these little dogs of Melita, so petted by Roman and Grecian ladies, were nothing else than our present dogs of Malta (Melita, by corruption, having become Malta). These dogs, which, in the last century, under the name of lap dogs, were the joy of dowagers, were carried by the Spaniards to their American possessions and have returned to us under the name of Havana dogs.

Oppian also, a Latin author of the third century, speaks of a small breed of dogs that was found in the British Islands, where it was used in hunting: "There exists for search," says he, "a certain breed of very brave dogs, small in size, but which is none the less worthy of being celebrated in our songs. They are raised by the wild Britons, who have the habit of painting the body, and who have given them the name of *agassins*. As for size, they in nowise surpass those worthless house dogs which get fat on the leavings of our tables. They have an arched body, very little flesh, and many hairs that obscure the sight, but their feet are armed with very strong claws, and their jaws with very sharp venomous teeth. However, it is for scent solely that the agassin has no rival, and it is eminently adapted for searching. . . . When this dog is taken on a true hunt, at liberty, he advances on the sly, his body close to the ground, and creeps along under the shelter of vine stocks and reeds. But, having reached the place where the hare has his home, our dog leaps with the swiftness of an arrow. . . . If he succeeds in surprising the animal, he very quickly gets the better of it with his sharp claws. Then he takes it in his jaws, and, in all haste, brings you the burden, which is an enormous one for him. Panting and bending under the weight, he reaches his master.

FIG. 5.—MALTA OR HAVANA DOG.

The latter, greatly pleased, hastens to go to meet him. Then, seizing both the conqueror and the victim at the same time, he lifts them high above Mother Earth and places them in a fold of his robe."

The majority of the authors who have occupied themselves with the origin of the breeds of dogs have thought that the agassins spoken of by Oppian were nothing else than our present terriers, without reflecting that the latter have rough coats and are true hounds. It is evident that it is a question of griffon terriers, such as have existed in England from time immemorial, and from which are derived the numerous breeds of terriers (now true house dogs, although still often employed against vermin), such as the Irish, Scotch, Gaulish, Bedlington, Dandie-Dinmont, Skye and other terriers, and even the little Brussels griffon and the German *singe*, which are derived from the first through degeneration. We say degeneration. It is, in fact, degeneration, the arrests of development, that are the principal cause of the formation of dwarf breeds. When we compare the skull of a pug dog, of a Blenheim, and especially of a Japanese *chin*, with that of a hunting dog of one of the typical species that we have already mentioned, we are struck with the great difference that such skulls exhibit. We observe that, in dogs of dwarf breeds, the cranium is rounded in such a way as to no longer show any traces of occipital or parietal

FIG. 4.—DWARF JAPANESE DOG.

(sagittal) crests. It is a conformation that we do not see in any species of wild ferines, not even in those that have the roundest head, like the cats.

It is easy to see that the cranial conformation of the dwarf dogs is the result of an arrest of development and of an early uniting of the bones of the head. In Fig. 1, we represent the cranium of an adult spaniel, in which we can see how greatly the occipital and sagit-

* Continued from SUPPLEMENT, No. 809, page 12828.

tal crests are developed. In Fig. 2, on the same scale, we represent the cranium of a young subject of the same breed, two months old. It can be seen that this latter cranium is perfectly rounded and that the sagittal and occipital crests are not yet even indicated. If, now, we compare this young cranium with that of an adult Japanese dog (Fig. 3), we see that the latter has the same frontal, parietal, temporal and occipital conformation. It has, moreover, aborted superior nasales, as in the bull dog, so that these little dogs are the result of a double teratological phenomenon, the arrest of development of the bones of the cranium and arrest of development of the superior nasal bones and of the maxillary bones.

The King Charles, the Blenheim and the pugs present the same cranial conformation as the Japanese dog, but it is in the latter that the characters of the group are the most marked. In the harrier there is crowding back of the bones of the nose. The arrest of development is simple to such a point that a harrier's cranium exactly resembles that of a young English greyhound two or three months of age. The advent of dwarf dogs is evidently due to chance, like the advent of the first bull dogs and the first terriers. An endeavor was made to multiply these curious beings, and this gave rise to the first house dogs. Their rarity, the difficulty of preserving them and the curiosity that they excited having rendered them valuable and high priced, a successful effort was made to produce them by processes that were, and still are, kept secret, and that were possessed, and certainly still are possessed, by English, Chinese and Japanese breeders. This industry is not only practiced with dogs, but especially with fowl.

One of these processes consists in the introduction of a certain quantity of alcohol into the food. Messrs. Maret and Combemale, professors at the Montpellier School of Medicine, have demonstrated that, by daily administering a non-toxic dose of alcohol to young dogs, there is brought about in them an arrest of development and an early coalescence of the bones of the cranium. It appears that the Japanese arrest the growth of the *chin* (Fig. 4) by the use of *saki*, a spirituous extract that they themselves make great use of. It is quite possible that it is from the extreme East that the knowledge of this method comes to us, for the industry of producing dwarf dogs has existed in China for ages. It is thence that came to us, two or three centuries ago, the pug and the little parlor spaniels, the King Charleses and the Blenheims.

Thirty breeds of house dogs are enumerated, but all are not equally in favor, or to the taste of the day, if one may say so, for the favor that certain of these breeds enjoy at a given moment is a pure matter of fashion. Much was made of the greyhound twenty years ago, and then it disappeared almost completely. It had replaced the pug, of which one would not have found two or three couples at the epoch in question. Now the pug has come to the surface again and shares the favor of ladies with the small griffons. To-morrow we shall, perhaps, see the greyhound make its appearance again. And so it is with all the fancy breeds, the principal ones of which we shall enumerate.

The little Dalmatian or Danish dog, which, fifty years ago, accompanied every stylish equipage, has since almost totally disappeared. From time to time, we still occasionally see fine specimens of it. It is a relatively large dog, which has the size and appearance of a light brach, and is characterized by a coat having a white ground strewed with round black blotches of the size of a one or five franc piece.

The poodle is derived from the hunting dog, and is very intelligent. There are white ones and black ones, and with woolly or stringy hairs. Black poodles have been much in favor for some years.

What is called the Italian greyhound is a miniature of the English greyhound. It has a coat as fine as that of a mouse, of the same color or tawny gray. It lacks scent, like all the harriers.

The *loulou* is a diminutive of the dog of Pomerania. The white loulou, the companion of the driver of stage coaches, has disappeared with the latter. For some years past, the black loulou has been much in favor.

The small parlor spaniels have the head of the pug with large, drooping ears, which, along with the tail and the rest of the body, are provided with long, wavy, silky hair, recalling that of the pointer.

Their names depend upon the color of the hair. The King Charles has a black coat, with flame color in the lower regions. The Blenheim is piebald black and orange. The Prince Charles also is piebald, but of three colors, white, orange, and black. Finally, there is a fourth sub-breed, which is entirely orange russet, like the Irish setter.

The pug is a bull dog in miniature, but with equal jaws. It has the coat of the mastiff, of cafe-au-lait color, and, like it, a black muzzle and wrinkled skin on the forehead.

The English terriers are of numerous varieties. Some have a short-haired coat, like the fox terrier, which, morever, is tricolored; the English terriers, some of which are all white, and others black and flame colored; and the bull terrier, which is a cross between the bull dog and the preceding. Others have a shaggy coat, such as the Irish terrier, which is entirely russet; the Welsh terrier, which is blackish gray and flame colored; the Bedlington terrier and the terrier of Airedale. Finally, there are terriers with short limbs and generally long and more or less shaggy hair, such as the Scotch terrier, the Dandie-Dinmont and the Skye terrier. There are toy or dwarf terriers, some having a smooth coat, and others having long and bristly hair, such as the Brussels griffon and the *affenpinscher* or German monkey griffon.

Finally, there is the Maltese or Havana dog (Fig. 5), which is entirely covered with long, silky, white hair, which causes it to resemble a more or less well combed ball of silk, and the Japanese dog (Fig. 4), which belongs to the group of small spaniels, but is still smaller and more exaggerated in all its characters.—*P. Megnin, in La Nature.*

THERE is no way of softening wood without injuring its strength. There is nothing used by wood benders to soften the wood but steam or hot water. If the wood can be steamed under a slight pressure, so that it will be fully up to 212° when bent, it makes better bends. Where large quantities of the same pattern are to be bent, a machine is used to save splintering.

TO THOSE WHO NEGLECT SHADOWS.

THE art of managing shadows is a matter of importance in photography. The art of forming them has given rise to many well known amusements. What child is there who has not amused himself in making silhouettes and in producing a series of figures as numerous as varied with the shadow of his two hands only? Is there not here an inexhaustible subject of amusement for an amateur photographer? The silhouette of a subject is something characteristic. Upon seeing the shadow, we at once recognize—the screen that has produced it!

Reader, you doubtless suspect that we are going to republish the story of the peasant who went to the curate to tell him that a ghost, having the form of a huge ass, followed him while he was walking in the moonlight along the wall of the church. We shall do better. We have here, in the figure, a series of drawings communicated by a kind contributor, and which show what can be made out of shadows. Doubtless, the humorous pencil that drew these silhouettes has sometimes indulged in a somewhat fantastic flight, but it must be admitted, after looking at them, that one would willingly let the prey go for the shadow.—*La Science en Famille.*

A STUDY OF SHADOWS.

MALARIAL MALADIES AND THEIR GEOGRAPHICAL EXTENSION.*

By Prof. ANGELO CELLI, Director of the Institute for Experimental Hygiene at Rome.

THE geographical domain of malaria on the surface of the earth is so vast that the limits allotted to my paper on this subject would not suffice for an enumeration of the most important malarial countries, and moreover, I should only repeat what has already been published by Messrs. Hirsch, Lombard, Bouchard, Boudin and others. Nor would the time be sufficient if I were to give a synoptical exposition of the distribution of malaria in a geographical domain even more limited.

I may remark that in the actual condition of science it is only possible to trace with tolerable approximation a general line of demarkation between the countries where malaria prevails. In fact, it has been said that the extreme limit toward the north of the boreal hemisphere coincides closely with the isothermal line + 5. Nevertheless, in examining one of the most recent meteorological charts we readily recognize that the said isothermal is exceeded at many points. We will perhaps approach the truth if we make the said line of demarkation coincide with the isotherm + 4, on the other side of which will still be found places where cases of malaria are observed, for example, Irkutsk and several other points of Siberia; Haparanda at the base of the Gulf of Bothnia (65° 5' lat. N.); Julianeshaav at the southern extremity of Greenland; New Archangel in the peninsula of Alaska (57° 3' N. lat.) Thus it will be seen that the domain of malaria in the northern hemisphere at times extends to very elevated latitudes.

On the other hand in the southern hemisphere, which is so poor in territory, it does not go beyond the 38th parallel, and its line of demarkation may be made to coincide with isotherm + 15.

As this coincidence is, however, only approximate, I prefer to confine myself to tracing the general lines, in order that with a uniform method we may be able, in the not remote future, to establish a chart of malarial territory as exact as possible. This would be extremely easy if such a chart were to be the same as that of the marshy regions; if malaria, this malady so typical of the territory, existed solely in certain districts; if it were confined to certain species of vegetation such as the marshy flora, rice plantations, etc. But on the contrary, to cite only a few examples, the malarial territory of Italy is unfortunately much more extensive than the marshy surface, which measures nearly a million of hectares, while there is no malaria in the whole expanse of the Rio de la Plata, the banks and islands of the lower Parana, the pampas of Peru, even in many places where there is much stagnant water or where the annual and estival temperatures exceed those of Rome. Under the same conditions, intermittent fever is relatively very rare in New Caledonia, in many points of the Australian continent, in the Bermudas, etc.

Malaria is to be found in territories of very diverse formation. The surface of the Roman Campagna is composed of at least thirty-five various kinds of soil, and there is not one which may be termed *a priori* non-malarial. In Spain they speak of the existence of malaria on granitic soil, and on the island of Madang in New Guinea it has been found on formations of coral.

It is true that, for the greater part, regions infested with malaria more or less grave in accordance with the latitude, are alluvia of slight elevation. Such are the maritime districts of South and Southeastern Asia, of Africa, and of a large part of America, in the fluvial regions of these countries, and in Europe in the lower basins of the rivers of the Spanish Peninsula, the western shores of France, the valley of the Rhone, the Netherlands, several points in the valley of the Rhine, the mouth of the Elbe, and the coasts of the Baltic Sea, the regions watered by the great rivers which flow into the Caspian, Azov, and the Black Seas, the basin of the Danube, the plains and valleys of Thrace, Thessaly, and Greece, a portion of the coasts of the Adriatic, of the Ionian Sea, and of the Tyrrhenian Sea, particularly the Pontine Marshes, the Roman Campagna, the Tuscany Marshes, and a large part of the shores and of the valleys of Sicily and Sardinia.

In all these regions there undoubtedly exists and flourishes a specific vegetation—the parasite of malaria. But under what conditions? Does it lead to a free life there, or rather (after the manner of certain myxomycetæ in the cells of the superior plants) an endocellular life, as in the blood? When the examination of a specimen of soil shall permit us to make diagnoses of malaria and its different forms, as we now make in examining a drop of blood, then we shall be able to draw a malarial map with the same exactitude as a geological chart.

Until the present time man is the only thermometer indicating the presence and the degree of malaria. But this thermometer requires several corrections. It manifests, for example, the influence of race; hence it is that populations inhabiting for centuries malarial regions experience their effects much less, and may even be relatively refractory: for example the black race, certain races of the Coromandel, and, among the natives of the Himalayas, the tribes of Avalia, etc.

We must also take into account the fact that malaria is very variable, according to the month and the year. In certain periods of the year it ceases, and in others it assumes an epidemic character, as during the spring or the autumn in northern regions. In the spring it is mild, and lasts but a short time. In summer and in autumn it is dangerous, as in the Roman Campagna, and it is only in summer and in autumn that in many districts of Russia it exhibits any degree of gravity. The rainy season also exercises an influence, as in the

* From *Medical Age*. Translated by Mr. Jos. Helfman, Detroit.

case in Sumatra, in New Guinea, and generally in the tropical regions.

To account for this local and temporary distribution of malaria, and its varying geographical distributions, the combined influence of temperature and humidity has been suggested. In this respect it would be well to make at the same time and in the same places climatological and nosological investigations. In this manner, we would be able to ascertain exactly how and in what reciprocal proportion these meteorological factors exercise their influence—how, for example, in the northern hemisphere the malaria advances as far as the isothermal line + 4, while in the other hemisphere it reaches only the isothermal line + 15.

Is this combined influence, indeed, the cause of the malarial pandemics?

In Latium the last general epidemic took place in 1879. After heavy rains, during the spring time, the fever raged in places whence it had long disappeared. In making up a malarial chart it would accordingly be necessary to distinguish the zones of endemo-epidemic from those subject to general epidemics or pandemics.

Moreover, it is well known that in the same localities the malaria may be aggravated or palliated by the labor of man. It will suffice to recall, on the one hand, the grand disturbances of territory, for example, in the digging of the isthmus of Panama, and, on the other, all the sanitary measures taken during the last two centuries. These efforts often only interrupt the development of malaria without destroying it—in such a manner that in a sanitary chart the places formerly infested by malaria are to be in general indicated as zones of latent malaria, or "zones once malarial."

Even without the intervention of man, malaria has during late years become more rare and less dangerous in many parts of Europe and America, as for example in Holland, in many districts of Belgium, in several localities of the United States (New Jersey, Michigan, Florida, etc.) In other places, on the contrary, it has undergone some augmentation, for example in Sweden, in the mountainous districts of Virginia, etc. In order, then, to classify a malarial country, it is necessary that observations be there taken during a number of years. Thus, from time to time—say every ten years—we could make corrections of the malarial chart and could follow its course. The observers will have to be numerous, for here it will never do to generalize on the basis of data obtained at a single point.

What a short distance sometimes separates, even in the most dangerous countries, the unhealthful localities from places perfectly habitable! The Sultanate of Dahli with its tropical malaria is very near to Singapore, the beautiful Naples of southern Asia. Of the chief cities of Europe, Rome, in the midst of a malarial region, is one of the most sanitary.

These differences often vary with the altitude of the temperature. In fact, while in Germany the malarial zone is bounded by an elevation of 400 to 500 meters, this boundary rises in southern Italy as high as 800 meters, and in the Himalaya mountains to about 2,000 meters, and even more above the level of the sea.

But especially in a vertical direction the malaria diminishes in gravity at altitudes much less considerable. Thus in countries subject to dangerous fevers, as in the Pontine Marshes, in Calabria and in Sicily, at an elevation of 300 meters, there is a zone of much milder malaria, which serves as a refuge for the inhabitants.

A malarial chart should hence indicate the different degrees of intensity of infection. For this purpose it is necessary to make conscientious medical observations, and as much as possible on disciplined individuals. In this respect the surgeons of the army and navy (particularly the French and English) have furnished and will be able to furnish still more precious material. Well directed colonial enterprises have afforded us some, and in the future will furnish still more. Finally, in civilized countries we may hope for much from the railroad surgeons. In order to demonstrate what may be obtained from the latter, I may cite an existing chart of the malaria prevailing along the Italian railroads. But to establish exact distinctions it is necessary to agree on the different forms of malarial infections.

In the fever countries, the physicians usually perceive malaria everywhere under the most diverse clinical forms. The progress of diagnosis by examination of the blood has already shed much light on the question. Any malady whatever may affect an individual formerly suffering from malaria, and may also be modified as malaria is itself modified by other dyscrasic conditions. But all these forms, modified by previous malarial infections, interest the clinician particularly, while medical geography concerns itself more especially with the actual forms of infection, whether they be isolated or associated with other infections.

Among these *forms of mixed infection*, or, as M. Torti has termed them, proportionate maladies, those which have without doubt been observed among us are tuberculosis, pneumonia, and brocho-pneumonia with the lanceolate diplococcus; erysipelas, with consecutive septicæmia from streptococcus; varioloid, and ulcerous enterocolitis.

The concurrent character of ulcerous enterocolitis and the malarial affections causes us to believe in the probable existence of a double infection of malaria and dysentery. The latter may by preference attack malarial patients, just as it attacks with greater readiness persons enfeebled by insufficient alimentation. But that is not all. It has even been said that dysentery is wholly a malarial affection, and several authors have described it as simply a malarial dysentery. This confusion is due to the fact that in certain countries the two maladies appear and augment concurrently in gravity in proportion as we approach the equator.

The same periodical course, sometimes the same fixation, more persistent in the neighborhood of places abounding in stagnant water, and their development following the drying up of this water, are the characteristics which have been considered common to the two maladies.

But without pretending that some of these relations may be simple coincidences, it is to be observed that dysentery possesses a character which imparts to it local bearings different from those of malaria, that is to say, contagiousness. It accordingly propagates itself with dejections, may travel with man, and knows no limits of altitude in any inhabited part. Even in winter, in the midst of centers of population, it may reach its maximum of intensity.

Is there any ætiological analogy between the two maladies? Is dysentery, at least in some regions, produced by an amœboid parasite?

Passing this question, respecting which observations made in Egypt seem in a measure to justify an affirmative answer, we must remember that malaria may appear with intestinal symptoms. In the common instances of malignant fever (Bignani) we observe in the capillaries of the intestinal mucous membrane a large number of parasites, and necrosis of the epithelium under the form of spots. In one case of choleriform pernicious fever, an enormous accumulation of parasites was observed in the vessels, as also superficial neurosis of the mucous membrane. This latter affection may perhaps be the results of a unique and autonomous infection.

But to generalize from these facts, can malaria be associated with cholera, as was stated in the observations made by the English physicians of Indo-China? May it also be associated with yellow fever, as they pretend to have observed in the East Indies? The reply will be given by modern ætiology. The latter has already shown several cases of typhoid fever and of mild concomitant or consecutive malarial infection during convalescence.

Now, is the typho-malarial fever described by the military physicians, in Algeria, in the American war, in the Turko-Russian war, and during the occupation of the isle of Cyprus, also a mixed infection? Examination of the blood in certain cases of typho-malarial fever, or a fever sub-continuo-typhoidic, does not reveal a double infection. In the few cases published with autopsy, they have found the organs melanotic and non-melanæmic, dealing therefore with anterior malaria and not with concurrent malaria. Besides, all the authors agree on the point that this fever is of a long duration and resists the action of quinine, while the most severe forms of malaria yield promptly to the action of this remedy. On the other hand, it is the custom, especially in warm countries, to attribute to the action of malaria every kind of fever. Hence we read in all the books that Massouah is not habitable for Europeans on account of the malaria. Examination of the blood in a large number of cases, typical of the Massouah patients, has excluded its malarial nature. The examination of the blood must, therefore, aid us greatly in correcting the malarial chart.

What we know of the pathogeny of the malarial infection justifies our regarding it as absolutely similar to that of bilious hæmoglobinuric fever, recently described in the tropical regions, for example, at Madagascar, in the Senegal, and at Guadaloupe.

At Rome, I had occasion to observe the case of a traveler who came from the Congo, and found in his blood the same little parasites which we discovered in our summer fevers. Among us this form was rare. The hæmorrhagic forms, in which we may have true hæmaturia, are also of slight frequency. But in all cases of severe fever polycholia exists—produced by the elimination through the liver of the hæmoglobin of the red, plasma-diaphoric globules which are affected by premature necrosis. There exist besides other red globules which expire prematurely by losing the hæmoglobin which dissolves in the plasma. If the latter does not exceed 60 per cent. (Ponfich) of the total quantity, it is eliminated like bile by the liver, which gives rise to polycholia; in other cases hæmoglobinuria may also exist, and, consequently, hæmoglobinuric fever. Cases of simple hæmoglobinuria have even been observed in individuals attacked by mild malaria. We cannot always succeed in provoking the access of hæmoglobinuria by cold. We cannot then speak of malarial infection as associated with paroxystic hæmoglobinuria. In all cases the question must be decided by examination of the blood.

With respect to the geographical distribution of the different forms in our warm climates—for example, in the Roman Campagna—we find all the forms prevailing on the surface of the soil. What we observe at the hospital of Santo Spirito from spring to summer and toward autumn is to be observed also in going from northern regions toward the equator. Hence in Holland, in Germany, etc., they have generally, in all seasons of the year, rather mild forms, as with us during winter and spring (tertian and quartan), while in the tropical regions, the same as in Italy during summer and autumn, severe forms predominate, that is to say, the true diurnal fevers, or with the attacks closely approaching one another, or remittent, or subcontinuous, and the malignant fevers. These dangerous forms in tropical regions are similar to those which have been observed in Italy, in Algeria, in Russia, in America; in the blood of the patients of all countries, as also of those who come from the Congo and from Madagascar, the same specific parasites have always been observed.

Even in tropical regions, malaria is a periodical malady dependent upon the seasons; hence when the endemic passes away, tertian fever is the type which predominates, as with us during spring time, and, just as in all malarial countries, the influence of race is also to be observed. M. Martin has made, near Sumatra, the interesting observation that, simultaneously and in the same places, the Europeans and the Chinese recently arrived are attacked by the severe forms, the Malays and Javanese by tertian, and the Tamils (who perform the most dangerous labors) escape, or suffer at most from quartan fever. On the other hand, under certain circumstances, the zones of mild malaria may change themselves into zones of severe malaria. As the result of an excessively warm summer, fevers similar to our æstivo-autumnal fevers were observed in 1826 on the German coast of the Baltic Sea; in 1854 at Breslau near an overflow of the Oder; in 1865 on a delta of the Elbe; and in 1859 in Lombardy, where malaria exists in rather mild forms, the French troops were attacked during the summer by severe forms of remittent malarial fever.

We may accordingly conclude that, considered from a clinical and epidemiological point of view, malaria is fundamentally the same everywhere on the surface of the earth, according to place and season, but does undergo transitory or more or less durable variations of intensity. These variations may even be epitomized in a single individual. By continuing to study in the same patients, during winter, the relapses of summer or autumnal fevers, we can observe the modification of severe into attenuated fevers.

But is there a clinical and epidemiological unity corresponding to the parasitic unity?

The different parasitic forms which one recognizes in the first microscopical examination of the blood correspond to the severe fevers of summer and autumn and to the attenuated fevers of winter and spring. Are these fevers species or fixed varieties, or are they generically different, as is affirmed by Messrs. Grassi and Feletti? Are they not rather varying forms of the same polymorphic parasite?

These are questions possessing an exclusively scientific interest, and which may be definitely solved by artificial cultures of the parasite. However, while waiting for definite proof, let us be permitted to make the following observations:

All the most important parasitic forms have the same commencement (little amœboid bodies), the same life and the same endocellular nutrition at the expense of the red globules. Sporulation proceeds in a manner essentially identical, as also certain final phases.

In the present state of science, a parasitic form, so to speak, of tertian or quartan fever, with premature sporulation, that is, before invading the whole red globule, is not to be distinguished essentially from a slightly pigmented parasitic form of summer fever.

The most important difference lies in the rapidity of development. In this respect:

1. The cycle of development may be very rapid, and we will have, without pigment, the forms of certain malignant infections.

2. The cycle of development may be rapid, and we shall have the slightly pigmented forms of æstivo-autumnal fevers and certain intermittent fevers (double-tertian, triple-quartan) with attacks in close succession.

3. The cycle of development may be slow, with gradual invasion of the red globule and with formation of spores in a number more or less great, and we will then have tertian or quartan fever.

These varieties of development may depend not only on different conditions, individual or congenital, of the organism, but also upon the centers in which they live. Among these latter conditions, the best known is the influence of temperature and humidity or that of the seasons and climates. Owing to this influence, in a zone of severe malaria, we find the summer and autumnal forms, and those of summer and spring, and hence we shall find different geographical zones of malaria, more or less severe, as we proceed from the malaria of northern countries toward tropical malaria.

In the foregoing classification are wanting the forms to which the first observers had attributed the most importance, viz., the filamentous. According to Laveran, these latter are still the most perfect forms, the true parasites of malaria, while everything would seem to support the belief that they are the forms in destruction.

There are wanting, besides, the semi-lunar corpuscles. But to-day we know that they bear no relation to the fever, that they do not cause sensible destruction of the red globules, and do not manifest the action of quinine.

With respect to the morphology of these forms, and particularly their manner of reproduction and their relations to other parasitic forms, there is yet much doubt, and even comparative parasitology of the blood has not yet succeeded in shedding all desired light on this subject.

It has been sought to solve the question of the unity or plurality of the parasites by experimental inoculations. The blood of patients suffering from well determined types of fever has been inoculated. In several cases it has been possible to reproduce the type and the corresponding parasitic forms, in other cases it has not been possible. The explanation of these differences is still in the domain of hypothesis. It is by reason of these latter facts, while awaiting further investigations which are to give us definite proof, that I hold it justifiable to admit that the clinical and epidemiological unity corresponds also to the parasitic unity.

RESUME.

1. It would be serviceable to prepare a chart of malaria, as exact as possible. This chart should be prepared under the co-operation of the epidemiologists of all countries, the surgeons of the army, of the navy, of railroads, of colonial enterprises, etc.

2. It would be well to adopt a uniform method for all the investigators, distinguishing the endemo-epidemic zones, according to the degree of intensity, as mild, severe, and very severe, and as far as possible the zones of general epidemic character and the zones formerly malarial.

3. It would be well to gather these observations during several years and at as many points as possible, confirming, wherever this would be necessary, the observations by the examination of the blood, and completing them as far as possible by meteorological observations.

4. Among the forms of malarial infection, those which are the most interesting from an epidemiological point of view are the forms of first invasion, and those which are associated with other infections. Among the latter we have up to the present time tuberculosis, pneumonia, broncho-pneumonia, erysipelas, septicæmia, varioloid, typhoid fever, ulcerous enterocolitis and, perhaps, also dysentery. It is probable that the fever termed typho-malarial is not malarial, while bilious hæmoglobinuric fever is malarial.

5. While awaiting definite morphological proof, we are allowed to admit that the parasitic unity corresponds also to the clinical and epidemiological unity of malaria.

Rome, Italy.

AN EXAMINATION IN PHARMACY.

I ENTERED the business about fourteen years ago, and during the first four of five years, in addition to shop duties, I went in for and obtained first-class certificates in the South Kensington examinations in elementary and advanced chemistry, but did very little else in the way of study, while of the remaining nine years I have not been able, owing to ill health to attend business more than half the time. Two years ago, however, I obtained a first class South Kensington certificate in elementary botany, but with that exception I did little earnest study until last spring, when I went to one of the large schools of pharmacy with the intention of going in for the July minor; but after a couple of months of moderately hard study I was again put back for four months by illness, and it was after that I took to my books again with the December examination in view.

These slight personal notes suffice to indicate the condition I was in mentally. I felt not very sure about any of the subjects; I had done my best at the books, and was fairly expert at the practical subjects, but I knew that much of what I had learned of the sciences in years gone by had evaporated, leaving but a faint residue of general principles. Upon this I had to start work, and had made fair progress when I came up to London a week before the examination.

The first day at Bloomsbury Square I spent in interviewing those who had been freshly plucked (passed men were generally too elated to give very coherent accounts), and their discouraging reports gave me the idea that I had not the ghost of a chance. So I resolved to interview no more unfortunates, and the rest of the days I devoted to looking up stray facts and examining the specimens in the museum.

I prepared myself bodily, as recommended in a back number of the *Chemist and Druggist*, by taking the following tonic for four or five days previous to the examination:

Acid. phosph. dil	℥ ij.
Strychniæ	gr. 1/6
Aquæ ad	℥ j.

A teaspoonful three times a day, and a double or treble dose just before going in.

Whether it was due to this or not, I can only say that as the day approached, I felt less and less nervous, and on the day itself I felt cool and collected, instead of being, as I was afraid, judging from my somewhat excitable temperament, so nervous as to be at a great disadvantage; and when once in the room nothing occurred which was at all likely to induce nervousness, my examiners all treating me with great courtesy and consideration—in fact, the much-dreaded *viva-voce* partook more of the character of a conversation with inquisitive friends than of a cross-examination by a more or less bullying counsel, as I had been led to suppose. On presenting myself at the examination hall I was at once sent off to

PHARMACY,

in which I was taken in hand by Mr. Tanner, who first gave me to recognize tr. opii ammon., questioning me as: How was it made? How much opium in a pint? How much in an ounce? Why was not morphia precipitated by the ammonia? He showed me two or three extracts, which I had a difficulty in recognizing. He remarked that extracts, as a rule, were difficult of recognition, handed me ext. colchic. acet. as one more easily recognized, and again asked, How was it made? Why allowed to stand? What did feculence consist of? What would be the consequence of feculence not being removed? Showed me aq. laurocerasi. What was its strength of hydrocyanic acid? How much was that in 1,000? How was strength estimated? Why add solution of soda? I was also asked to give another process of estimation, and I stumbled a little here, but on receiving a hint from him that there was a gravimetric process, I remembered it and gave him an outline of it. Ung. gallæ c. opio was next given, the questions asked being—What was its strength? What basis? What other ointment was similar in color? Told me ung. bellad. What bases were used for B. P. ointments? How was ung. hyd. nitratis made? Was the mercury mercurous or mercuric? I was then dismissed to the "funking" chairs, having been able to give fairly satisfactory answers to almost all the questions; but twice or three times when I stumbled I received a kind hint which helped to set me on my feet again. My next subject was

CHEMISTRY,

in which I was examined by Mr. Davies, who first asked me to recognize $HgCl_2$, Pb_3O_4, NaHO in sticks (I called this potassic hydrate), $KC_2H_3O_2$, AmCl, $Fe_2 2PO_4$, PbI_2 (which I did not identify). The questions were somewhat as follows: Give the formula of each. How was each made? Give equations for the manufacture of $Fe_2 2PO_4$, and for the action of nitric acid on red lead. How much CO_2 by weight is obtainable from 10 grammes of Na_2CO_3, and what volume would it occupy? What other oxide of carbon is there? How made? How would you prepare a definite quantity of it? He then gave me a solution to test, which I found to be acetate of sodium, and then he questioned me a little on my method of proving it. How distinguish the red coloration produced by the acetate with ferric chloride from those produced by sulphocyanides, or meconates. I could not answer this satisfactorily, so he told me what the distinctions were. On my asking for sulphureted hydrogen I was told that I should find a solution of it among the other reagents. I found it labeled "hydrosulphuric acid." Mr. Davies then gave me phosphate of calcium to test, and as I fortunately knew the special test for it (ammonium acetate and chloride of iron) I soon proved it. Next he took me on physics, and asked: What was air? How prove the oxygen in it? How prove it to be a chemical mixture, not a chemical compound? I told him one method, but he said that shaking it up with recently boiled water, and noting that some of the oxygen was dissolved, was a better way. What was that instrument on the table? A barometer. What was its use? He told me to select a specific gravity flask, and asked: What was it? How take the specific gravity of a solid soluble in water? Had one sum to work out in connection with specific gravity which he did not require me to finish, as he said he saw I knew how to do it.

This ended my examination in this subject, throughout which Mr. Davies was very friendly, giving me opportunities of correcting myself three or four times when I made slips in one of the equations, and in the working of the sums, etc.

MATERIA MEDICA.

Mr. Druce next took me in materia medica, showing me the following specimens, and asking the botanical sources, habitats, and natural orders of each: *Calabar bean:* What was its active principle? Was it an alkaloid, or what? What were the B. P. preparations of it? *Santonica* (two varieties): What was its active principle? What did "Maritima" mean? *Elder blossom. Cinchona Calisaya*, I think it was; I called it so, at any rate. *Jalap* (two kinds): Which was the "false" jalap? *Balsam of Tolu:* What was it? What was the definition of a balsamic resin? What was its active principle? *Lobelia:* What was the meaning of "Inflata"? To what part of the plant did "Inflata" apply? I could not tell him this. In what form was it usually imported? *Black hellebore. Veratrum viride. Belladonna leaves:* What was the active principle? *Jaborandi. Eucalyptus leaves:* What was the active principle? Was the oil fixed or volatile? *Cherry laurel leaves:* Active principle of aq. laurocerasi? Percentage of HCy? How much was that? (1 in 1,000.) This ended materia medica. I missed some of the habitats and natural orders, and failed to recognize one or two of the specimens, and generally felt that I had not done so well in this as in the two previous subjects.

BOTANY.

After ten minutes or so on the chairs I was sent to botany, where I had Mr. Bowen, who first handed me a few fresh plants for recognition; but as practical botany is not a strong point of mine, I did not do very brilliantly over these, and was not sorry when he changed the subject more toward structural botany. He gave me a plant to describe botanically and then asked me several questions as to the functions of leaves and their structure. Had the leaves of aquatic plants any stomata? What was the simplest plant I knew? I said the snow plant. "Yes," he remarked, "but the yeast plant is equally simple." Describe the general structure of a cell. Give composition of cell wall, and of protoplasm. Where were the nitrogen and sulphur obtained from? Mr. Bowen gave me a question or two on cell formation, and asked if I knew anything about the process of reproduction known as 'conjugation of cells." I did not. He then gave me a lecture, illustrated with pen and ink sketches on his blotting pad, on this subject, lasting five minutes or so. I was all the more interested in this, and took it as a sign that I pleased him pretty well. He then showed me a jaborandi leaf, which I recognized after receiving a hint from him as to its habitat. What was the fruit of wheat? What was the inflorescence of wheat? What were the botanical names of wheat, oats, barley? This finished botany.

I was then told off to

DISPENSING,

where I found myself under Mr. Greenish's wing. He gave me the following, saying that he would give me an hour to do them in, and asking if I did not think an hour was sufficient, which I certainly did:

Tr. camph. co.	℥ ij.
Tr. benzoin co.	℥ iv.
Mucilag.	℥ iv.
Sirup	℥ iv.
Aquæ ad	℥ iv.

M. Ft. mist.

Two teaspoonfuls twice a day.

Calomel	gr. iv.
Rhei. pulv.	℥ ss.

Make into eight pills.

One every night.

I set to work very deliberately, and got them done without flurry about twenty minutes short of the hour, and then had the following ointment to dispense:

Zinci oxid.	℥ j.
Bismuth. trisnit.	℥ j.
Vaseline	¾ oz.

Sig.: The ointment.

This, of course, presented no difficulty. I rubbed the oxide and subnitrate very smooth with olive oil before adding the vaseline. After my work had been examined I was once more relegated to the "funking chairs." I was in the dispensing room a much shorter time than I had expected. I may say that during the time I was in the room I noticed nothing at all approaching the badgering of candidates which is popularly supposed to be the habit of one of the examiners.

Considerable doubt exists as to what is and what is not allowable in examination dispensing, but I think it may be taken for granted that whatever methods would be sanctioned in any first-class dispensing establishments would be considered allowable by the examiners.

PRESCRIPTION READING,

which was my next and last subject, was one which I was rather nervous about, owing to the discouraging reports I had heard of the rate at which candidates were being rejected in it; but, evil reports notwithstanding, I found that I was asked little by my examiner (Mr. Taylor) which I was unable to answer, and the six or seven prescriptions he gave me to read in extended Latin were such as may be met any day in an ordinary dispensing business, and presented no unusual difficulties in the way of illegibility. Mr. Taylor asked me the doses of the following: Ext. nuc. vom., ext. bellad., ext. bellad. alcohol., tr. nucis vom., tr. bellad., hyd. bichlor., liq. hyd. bichlor., liq. strychninæ, liq. arsenicalis, arsenic, strychnine, and a few others. What was syr. ferri phosph. c. quin. et strychnia? What was the proportion of strychnine in it? He gave me the following to put into full Latin:

Take of—

Subcarbonate of bismuth	80 grains.
Carbonate of soda	90 "
Spirit of ether	70 minims.
Mucilage of tragacanth	1½ oz.
Water to	12 "

Make a mixture. One-twelfth part to be taken every five or six hours when difficulty of breathing comes on.

This concluded my last subject, and then followed a few minutes' suspense before I learned whether I had obtained sufficient marks in the aggregate to pass me. However, the chairman soon called me up, and with a bland smile and shake of the hand informed me that I had satisfied my examiners, and congratulated me on it. I then took my departure, feeling at peace with mankind in general and examiners in particular.

My experience in the examination room entitles me to say that if a man understands what he is talking about he will not be called upon to answer any abstruse questions; but if a candidate gives a correct answer more by force of memory than because he understands the principles involved, and is consequently unable to explain his own answer when cross-examined on it, it is only natural that an examiner should suspect that he is crammed. Then he proceeds to apply the "confirmatory test" of more searching questions, under which the candidate possibly breaks down, and retires with the idea that the examiner was very much down upon him; but had he not been crammed more or less, he would probably have had much simpler questions.—*Chem. and Druggist.*

A SIMPLE AND RAPID METHOD OF GRAVIMETRIC ANALYSIS.

By G. H. BAILEY, D.Sc., Ph.D., and J. C. CAIN.

THE method is practically that by which the specific gravity of a solid would be taken, viz., by means of weighing in suspension in liquid. Although in this way the weight of the solid suspended in a liquid is frequently made use of as a means of determining its specific gravity, we are not aware that conversely the specific gravity (known or determined once for all) has ever been made use of for ascertaining the actual *weight* of a precipitate directly and without it being separated by filtration from the liquid. Some time ago Dr. J. Grossmann, a member of our society, made some preliminary investigations in the direction indicated, but these were not published.

DESCRIPTION OF APPARATUS.

An ordinary specific gravity bottle might be used for the determinations, or even a 100 cc. flask. Indeed, the first part of our work was carried out with such a flask. The former, however, had its inconveniences, and the latter was too wide in the neck to admit of sufficiently accurate measurement. We therefore constructed a form of flask and fittings thereto which should overcome these difficulties. The 100 cc. flask is made in two parts, as shown in Fig. 1, the neck being in a separate piece and accurately ground into the body of the flask. It is desirable, indeed, to make the neck almost capillary for the purposes of accurate reading, so that to facilitate the introduction of the liquid (and suspended matter) into the flask, it is necessary to make this capillary neck removable. With the arrangement shown in Fig. 2, it is easy first to fill the flask, A,

FIG. 1.

FIG 2.

with the liquid and precipitate, and then fit in the capillary neck, B, and add a little more liquid until a given mark on the stem was reached. The stem is furnished with graduations in millimeters. These serve not only to adjust accurately 100 cc. of liquid at 4° C., but also (the capacity of the stem being once for all determined) enabled us to get rid of the troublesome cooling (or warming) process used in specific gravity determinations where all weighings are made with the liquid at a given temperature. For instance, if the liquid at 4° C. (point of maximum density for water) stood at division 6 for 100 cc. liquid, and at 10° C. it stood at division 9, it is evident that when working at 10° C. the flask must be filled up to division 9 to represent 100 cc. of liquid at the point of maximum density of water. In order to further facilitate the introduction of the liquid containing the precipitate into the body of the flask, especially as 150 or 200 cc. of clear supernatant liquor had to be decanted off for another purpose, the cup-shaped vessel, C, also ground so as to fit into the flask, is used.

METHOD OF WORKING.

First, the specific gravity of the substance precipitated is carefully determined by ascertaining (*a*) weight of flask and air, and then deducting from this the weight of 100 cc. of air; (*b*) weight of flask and 100 cc. of water at 4° C.; (*c*) weight of flask filled to 100 cc. mark with water and the substance whose specific gravity was to be determined. The following values were obtained:

Silver chloride precipitated in the hot	5·298
Silver chloride precipitated in the cold	5·287
Copper oxide precipitated in the hot	6·514
Ferric hydrate precipitated in the hot	2·583
Barium sulphate precipitated in the hot	4·651
Barium sulphate precipitated in the cold	4·612

Each of these values is the mean of several determinations which closely agreed among themselves. It will be seen that, as might be expected, the density of the product varies somewhat according to the circumstances under which the precipitation is effected. The determinations made in the hot were boiled for some time, as in the ordinary course of analysis, and the values were practically uninfluenced, as far as our experience goes, by prolonging the period of boiling, or by the state of dilution when the precipitation is effected, at any rate within such limits as occurred in actual practice. In order, however, to make use of these numbers in the inverse manner for ascertaining the weight of a given precipitate, it is not necessary to replace the supernatant liquor by water, for by using two similar flasks, 100 cc. of the clear supernatant liquor may be run off into one flask, leaving the precipitate and supernatant liquor occupying 100 cc. in the other flask. Some of the supernatant liquid may

also be transferred to a small wash bottle for convenience of washing down any precipitate which remains attached to the sides of the cup-shaped vessel. The actual determination of the weight of the precipitate, W, now takes this form:

$$W = \frac{(w' - w)\, Vs}{Vs - W}$$

Where

w' = weight of supernatant liquid and precipitate,
w = weight of known volume (say 100 cc.) liquid.
s = specific gravity of precipitate.
V = volume of the flask (say 100 cc.).

As an instance of the weighings to be made, we give the following numbers, obtained in determining the amount of chlorine (as silver chloride) in a solution of common salt:

Flask and liquid with silver chloride	123·551
Flask only (determined once for all)	20·972
w' =	102·579
Flask and liquid	122·341
Flask only (determined once for all)	21·724
w' =	100·617

$$W = \frac{1{\cdot}962 \times 539{\cdot}8}{539{\cdot}8 - 100{\cdot}617} = 2{\cdot}422 \text{ grms.}$$

Two weighings only are, therefore, required. The following numbers obtained by this method will show the extent of the variation which may be expected with careful working. The silver chloride determined gravimetrically was found to be 2·422 grms.

	Grms.
Experiment 1 gave	2·422
" 2 "	2·426
" 3 "	2·420
" 4 "	2·424

That is to say, the error in a chlorine determination, taking the value which shows the greatest divergence, will amount to less than one-twentieth per cent. It is not, of course, contended that the method is to be preferred to the ordinary gravimetric determination on the score of accuracy, but rather that it effects a saving of time, especially where a number of similar determinations have to be made from day to day, and where the amount of material is sufficient to yield a precipitate of two or three grammes. As a matter of fact, a determination may be made, after the precipitate has been effected, in half an hour, and a dozen similar determinations done simultaneously in a dozen flasks would occupy very little more additional time than that required to make the necessary weighings. Of course the analysis of a substance involving several determinations—such as the iron, copper, and sulphur in a cupreous pyrite—can be made quite as readily. A determination of iron and sulphuric acid in a solution of ferrous ammonium sulphate gave the following results:

	Found.	Calculated.
Fe.	0·8642	0·8233
SO_4	2·788	2·758

The following observances have suggested themselves in the course of working out the details of this method of analysis: (1) Where the precipitate forms a double salt with any of the substances existing along with it in the solution, regard must be paid to this (as it must also in the gravimetric method) and precautions taken. Some soluble salts (the alkalies, for instance, by barium sulphate) are really carried down with the precipitate where the solution is a concentrated one, and must be washed out with hot water. It is best, however, to precipitate with the precautions usually observed, using dilute solutions. (2) The method can only be recommended where a sufficiently large quantity of precipitate is obtainable—say 2 grms. Of course it is possible to work with small quantities, but then the experimental error becomes large, unless greater care is exercised than is to be expected in routine determinations. (3) For determinations where the precipitate cannot be washed free from the other liquor without loss, this method may be recommended as preferable to the gravimetric method. Such are the determinations of fluorides, borates, phosphates, and several of the more troublesome sulphides. In the latter case the precipitation can be effected by passing the sulphureted hydrogen directly into the flask, and thus all fear of alteration by oxidation, etc., is avoided.—*Jour. Chem. Industry.*

ARTIFICIAL HORNBLENDE.

THE mineral hornblende has been artificially reproduced in well-formed crystals by M. Kroustchoff, and an account of his experiments has been communicated to the *Comptes Rendus*. His process essentially consists in digesting together for a long period of time, *in vacuo*, and at a high temperature, the various oxides contained in natural hornblendic amphiboles, in presence of water. Small flasks of green glass were employed, each of which was exhausted by means of a Sprengel pump after the introduction of the substances to be digested together. The ingredients digested consisted of, 1, a dialyzed 3 per cent. aqueous solution of silica; 2, an aqueous solution of alumina obtained by dissolving aluminum hydrate in an aqueous solution of aluminum chloride and subjecting the solution to dialysis; 3, an aqueous solution of ferric oxide obtained by the addition of ammonium carbonate to ferric chloride in such quantity as to redissolve the precipitate first formed, and dialyzing the solution; 4, carefully prepared pure ferrous hydrate; 5, lime water; 6, freshly precipitated hydrate of magnesia; and, 7, a few drops of caustic soda and potash. The mixture presented the appearance of a gelatinous mud. The exhausted and sealed flasks were placed in a specially constructed iron many-chambered furnace, and heated for three months to a temperature of 550° C. At the expiration of this time the appearance of the contents had entirely changed, having become much darker in color, and distributed throughout were numerous brilliant little crystals, almost black in color, and reminding one forcibly of natural hornblende. In addition to these crystals of hornblende, pyroxenic crystals resembling those of the augite family were also found in the flasks, together with crystals of zeolite and of a variety of orthoclase felspar. And, finally, some exquisite little quartz crystals were observed, showing cavities containing liquids and bubbles resembling those of natural rock crystals.

KAOLIN BEDS.

A PAPER by W. O. Crosby in *Technology Quarterly* describes the kaolin beds of Blandford, Mass., which have, during the past year, only just been opened up sufficiently to allow of an examination of the geological surroundings and the formation of an opinion as to the origin of the deposits.

He describes the geological position in considerable detail, and from a consideration of it the kaolin appears to have been derived from large veins of coarse pegmatite or endogenous granite, containing little mica, and consisting chiefly of felspar. It is clearly a product of decomposition *in situ* in pre-glacial times—a genuine remnant of an ancient sedentary soil, which has escaped the erosive action of the great ice sheet.

The following is an analysis:

	Per cent.
Silica	52·03
Alumina	31·76
Water	15·55
Magnesia	0·54
Oxide of iron	Trace
Lime	Trace
Alkalies (K_2O and Na_2O)	Trace
	99·88

The structural features of the kaolin, the scattered crystals rotted to mud but still intact in form, go to prove that the kaolin was never washed into the position in which it is found.

A New Catalogue of Valuable Papers

Contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address. MUNN & CO., 361 Broadway, New York.

THE SCIENTIFIC AMERICAN Architects and Builders Edition.

$2.50 a Year. Single Copies, 25 cts.

This is a Special Edition of the SCIENTIFIC AMERICAN, issued monthly—on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid **Magazine of Architecture**, richly adorned with *elegant plates in colors* and with fine engravings, illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction.

Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost *endless series of the latest and best examples* from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of Grounds, etc., are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described and illustrated, with addresses of the makers, etc.

The fullness, richness, cheapness, and convenience of this work have won for it the **Largest Circulation** of any Architectural publication in the world.

A Catalogue of valuable books on Architecture, Building, Carpentry, Masonry, Heating, Warming, Lighting, Ventilation, and all branches of industry pertaining to the art of Building, is supplied free of charge, sent to any address.

MUNN & CO., Publishers,
361 Broadway, New York.

Building Plans and Specifications.

In connection with the publication of the BUILDING EDITION of the SCIENTIFIC AMERICAN, Messrs. Munn & Co. furnish plans and specifications for buildings of every kind, including Churches, Schools, Stores, Dwellings, Carriage Houses, Barns, etc.

In this work they are assisted by able and experienced architects. Full plans, details, and specifications for the various buildings illustrated in this paper can be supplied.

Those who contemplate building, or who wish to alter, improve, extend, or add to existing buildings, whether wings, porches, bay windows, or attic rooms, are invited to communicate with the undersigned. Our work extends to all parts of the country. Estimates, plans, and drawings promptly prepared. Terms moderate. Address

MUNN & CO., 361 BROADWAY, NEW YORK.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. CHEMISTRY.—A Simple and Rapid Method of Gravimetric Analysis.—By G. H. BAILEY.—An interesting and novel method of chemical analysis based upon specific gravity of precipitates, with tabulation of results and description of apparatus.—2 illustrations. 12913

II. DRAWING.—The Spirograph.—Description of an instrument for drawing spirals, with samples of its work in pencil and ink.—2 illustrations. 12905

III. GEOGRAPHY AND EXPLORATION.—Peary's Greenland Trip.—By R. E. PEARY, U.S.N.—Lieut. Peary's own account of his exploring party for the discovery of the northern terminus of Greenland, an elaborate description of the plan and prospects of the party and of their equipments.—Notes upon a second Arctic expedition for investigations upon the east coast of Greenland under Lieut. Ryder. 12908

IV. GEOLOGY AND MINERALOGY.—Artificial Hornblende.—Formation of this mineral artificially.—A very curious example of synthetic mineralogy. 12914
Kaolin Beds.—Notes on the newly opened kaolin beds of Blandford, Mass., with analysis of the kaolin found there. 12914

V. MECHANICAL ENGINEERING.—Atkinson's Cycle Gas Engine.—An ingenious gas engine, so arranged that in one revolution of its crank the suction, compression, working, and exhaust strokes are all produced.—2 illustrations. 12907
Swing Jib Countersink Drilling Machine.—A drilling machine with a capacity for ship plates, 5 x 16 feet in area, without moving the plate.—1 illustration. 12908

VI. METEOROLOGY.—New Registering Barometer.—Radier's registering aneroid barometer. 2 illustrations. 12906
The Statoscope.—Another aneroid barometer constructed by Richards Brothers, with descriptions of its application.—1 illustration. 12906

VII. MISCELLANEOUS.—To Those who Neglect Shadows.—A series of curious shadow pictures, giving an interesting series of silhouettes.—1 illustration. 12911

VIII. MEDICINE AND HYGIENE.—Malarial Remedies and their Geographical Extension.—By Prof. ANGELO CELLI.—The geographical distribution of malaria, and a review of its bacteriological status and the effect of this type of diseases upon the blood. 12911

IX. PHARMACY.—An Examination in Pharmacy.—The London examination in pharmacy.—An interesting example of how druggists' examinations are conducted in England. 12912

X. PHYSICS.—An Inexpensive Mercurial Air Pump.—By R. W. WOOD, JR.—Description of an air pump requiring comparatively simple parts.—1 illustration. 12905

XI. TECHNOLOGY.—Floating Soaps.—Details of the process of making floating soaps, thereby disposing of trimmings from cocoanut oil soap. 12904
Nomenclature or Vernacular in Brick Making.—By S. K. FLETCHER.—The language of brickmakers.—Peculiarities of the manufacturing terms in different parts of the country. 12904
The Manufacture of Liquid Carbonic Acid Gas.—The manufacture of liquefied carbon dioxide, as conducted in Paris.—4 illustrations. 12903

XII. TOPOGRAPHY.—Simple Method of Measuring Heights in Hasty Topographical Surveys.—The use of a simple piece of section paper for determining the height of distant objects.—An excellent suggestion for rough field work.—3 illustrations. 12906

XIII. ZOOLOGY.—Animal Life on a Coral Reef.—A review of the fauna of the coral reefs and of the conditions of life in the neighborhood thereof. 12909
The Breeds of Dogs.—A continuation of this interesting article, describing several kinds of toy dogs, with views of skulls and of different living specimens.—6 illustrations. 12909

Useful Engineering Books

Manufacturers, Agriculturists, Chemists, Engineers, Mechanics, Builders, men of leisure, and professional men, of all classes, need good books in the line of their respective callings. Our post office department permits the transmission of books through the mails at very small cost. A comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of author. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address,

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *forty-five years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Labels, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.

The Scientific American Supplement. Index for Vol. 31.

JANUARY–JUNE, 1891.

The * Indicates that the Article is Illustrated with Engravings.

A

Acid, carbonic, liquid....*12903
Acid, hydrazoic....12533
Acne....12646
Adherence, magnetic....*12812
Aeronautics, marine....*12519
Africa, notes on....12879
Age and brain work....12717
Agriculture, electricity in....*12871
Air, compressed, Paris syst....*12830
Air, compressed, for power....12519
Air compressed, production....*12763
Air compressor, hydraulic....*12767
Air compressors....*12764
Air, is it navigable....*12743
Air pump, a new....*12905
Air, volume and weight....12763
Alexandria breakwater....*12846
Alimentation in therapeut....12509
Alloy, iron-aluminum....12642
Alloys of iron and aluminum....12712
Aluminum....12614
Aluminum, manufacture....*12550
Aluminum steel....12712
Amalgams, property, changes of *12561
America, impressions....12888
Analysis, gravimetric....*12913
Andes, railway through....*12899
Angle, economical....*12541
Angles, trisection of....12570
Aniline dyes....12797
Aniline colors made soluble....12508
Animal, a strange....*12596
Animal life on coral reef....12909
Animal tissues, preserving....12882
Animals, sep. from plants....12581
Ant-eater, giant....*12061
Antiseptic, perox. of hydrogen as 12717
Agriculture....12565
Apple crop, protection of....*12883
Apple tree caterpillar....*12824
Apples, our 20 best....12566
Aræo-picnometer....*12687
Aristolochia longecaudata....*12528
Armor, modern....*12829
Armor-plate tests....*12892
Arrowroot starch....*12770
Artillery steel, tests for....12856
Astronomy of next decade....12595
Astronomy, researches in....12528
Asylum, insane, Matteawan....12810

B

Bacteria, pathogenic, harm....12597
Battle, naval, miniature....*12890
Bugs, paper, machine for....*12590
Balances of precision....*12769
Baldness, cure for....12845
Balloon, captive, German....*12519
Bands, spectral, faint....12898
Banjo frets, spacing for....*12686
Barometer, air, improved....*12906
Barometer, registering....*12906
Bath, toning and fixing....12878
Battery, bisulph. mercury....*12660
Battery, caustic potash....*12660
Battery, dry, Gassner's....*12660
Battery, Edison-Lalande....*12659
Battery, Hussey....*12660
Battery, Lalande-Chaperon....*12660
Battery, plunge, powerful....*12659
Battery, simple....*12690
Battery, storage, improved....*12866
Battery, Urquhart's....*12658
Batteries, connecting....*12656
Batteries, high power....12873
Battle ship Royal Sovereign....*12807
Bearings, journal, friction....12554
Beer, treatment, etc....12779
Beethoven....*12840
Beetles, cocoanut....12785
Bell, Jacob....12725
Bennington, gunboat....12796
Berthe Quay....*12830
Blackings, harness....12842
Bleaching, electric....12757
Bleaching, permang. potash....12758
Blind, arts of the....12544
Blowpipe, tests with....12906
Boat, dispatch, Meteor....*12759
Boat, electric....*12558
Boat, passenger, Tunis....*12749
Boiler for car heating....*12751
Boiler crust, tannin vs....12561
Boiler deposits....12843
Borax extraction, Calif....12886
Borer, stalk....*12825
Bourgogne, steamer....*12888
Brain work and age....12717
Breakwater, Alexandria....*12846
Breakwater, Cherbourg....*12858
Breakwater, Plymouth....*12858
Brick, fibrous....12841
Brick making, vernacular in....12904
Brick wood....12841
Bridges, railway....12543
Brontosaurus, restoration....*12804
Bud moth....*12818
Budapest, exhibition at....12879
Bug, squash....*12819
Burnham, N. F....*12701
Butter, composition of....12676
Butterfly, cabbage....*12824

C

Cabbage butterfly....*12824
Cabbage leaf miner....*12826
Cable, wire, Midgley....*12354
Cables, ocean, slack of....12587
Cables, submarine....*12702
Cables, submarine, growths on....12590
Calendar, perpetual....12728
Camera, photo., detective....*12878
Candle burning in water....*12786
Cannon, machine, Hotchkiss....*12647
Car, hand....*12835
Car, street, electric motor....*12806
Car wheels, best diameter....12679
Cars, heating, new method....*12750
Cars, storage battery, note on....12747
Carbon, condensation....*12651
Carbon and fluorine....12534
Carbon in organic subst....*12693
Carmine, cochineal....12902
Carpet, reversible....*12687
Carrier, aerial....*12874
Catalpa....*12537
Caterpillar, apple tree....*12825
Caterpillar, grape vine....*12825
Caterpillar, tent, forest....*12825
Ceiling, Pompeian....*12801
Cell, bisulph. mercury....*12660
Cell, Lalande-Chaperon....*12660
Cement, magnesia, applic....12811
Cement tester, new....*12538
Cement, testing....12898
Charleston, U. S. ship....*12555
Cherbourg breakwater....*12858
Cherry tree, disease of....*12738
Chicago, decorated gardens of....*12711
Chicago, elevated railway for....*12543
Chicago, Internat. Exhib....12514
Chicago as a seaport....*12700
Chickens, rational feeding of....*12709
Chlorine, effect of silent disch....12693
Chlorine process, new....12561
Chlorine water, act. of light....12534
Christia....12902
Chronometer of precision....*12876
Cinereine....12728
Circuits, telephone disturb. in....*12902
Circus ring, flooding....*12578
Clay workers vs. lumbermen....12841
Cloisonne, use of....*12790
Cloth, knife to cut....*12650
Coal fields, Alabama....12530
Coal mines, electricity in....12513
Coal tar dyes....12797
Coast defender Monterey....*12855
Cochineal carmine....12902
Cock sole....*12782
Cocoanut butter....12785
Codling moth....12826
Coils, winding....*12521
Colbert, warship....*12567
College, Sibley, lectures....*12763
Colombo harbor....*12858
Color, dye, new....12728
Colors, aniline, made soluble....12508
Colors, complementary....*12786
Colors, photography of....12871, 12780, *12878
Colorado, notes on....12639
Comatula, motion of....*12532
Combustion of gaseous mixt....12806
Combustion, spontaneous....12753
Commutator, electrostatic....*12848
Compression, adiabatic....12880
Compressors, air....*12764, *12832
Compressor, air, hydraulic....*12767
Concord, gunboat....12796
Condensers, current....*12702
Conduit, electric railway, *12673, *12815
Conic sections....*12836
Consumption, hydrastis in....12002
Consumption, philosophy of....12004
Copper, electrolytic, refinery....12872
Coral growths on cables....12606
Coral reef, animal life on....12909
Cork industry, Spain....12901
Corn, Indian, product, new....12865
Corn starch....*12770
Cornus florida....*12853
Cotton industry, history....12877
Crane, overhead, steam....*12679
Crookes, William....*12654
Cruiser Charleston....*12555
Cruiser De Mayo....*12503
Cruisers of Europe....*12776
Cruiser Pelayo....*12777
Crust, boiler, tannin for....12561
Cryolite mine, Greenland....12665
Crystals, rejuvenescence....12757
Cupressus nabiana....*12854
Curculio, plum....*12820
Currents, alternating, phenom....12657
Current condensers....*12702
Current wheels, power....*12768
Curves, drawing....*12721
Curves, rolling....*12641

D

Dab, sand....*12782
Dahlias, dwarf, new....*12603
Dandruff, persistent....12645
Davenport, T., inventions....12744
Degras, analysis of....12867
De Mayo, cruiser....*12503
Developer, hydroquinone....12877
Developer, soda....12877
Diet of chickens, effect of....*12709
Diphtheria germicides....12785
Diphtheria, treatment....12550
Discharge, silent, on chlorine....12693
Dissociation phenomena....*12668
Distances at sea, to find....*12670
Dogwood, flowering....*12853
Dogs, breeds of....*12827, *12910
Dover pier....*12858
Drill, electric, marine....*12561
Drills, diamond, antique....12561
Drilling machine, countersink....*12908
Dust, spectroscop. properties....12609
Dye, color, new....12728
Dye, yellow, milling....12525
Dyes, coal tar....12797
Dynamo, great, at Paris....*12743
Dynamo, plating....*12674
Dynamometer to test machines....*12569

E

Earth, morning star of Mars....*12638
Earth, revolution of....*12786
Earthenwares, porous....12840
Eggs, snake, incubation....12563
Electric ballistic target....*12574
Electric bleaching....12757
Electric boat....*12558
Electric drill, Marvin....*12511
Electric erygmascope....*12574
Electric headlight....12524
Electric locomotive, mining....*12512
Electric motor....*12691
Electric motor, Henry's....*12848
Electric motor for organs....*12525
Electric motor, small....*12510
Electric motor, street car....*12887
Electric police apparat....12721
Electric power, elev. railways....12617, *12843, 12872
Electric power transmission....*12511
Electric railway conduit, *12673, *12815
Electric railway, notes on....12722
Electric railway work, fast....*12745
Electric science, and invention....12802
Electric snow sweeper....*12594
Electric transmission, Aspen....12513
Electric transmis. pictures....*12558, 12559
Electric units....12736
Electric welding....*12546
Electricity in coal mines....12513
Electricity, effect on plants....*12671
Electricity, photo....12894
Electricity, tanning by....*12524
Electricity in transita....*12664, *12704
Electricity in tunneling....12503
Electrode matter, radiant....*12704
Electromagnet....*12622, *12547, *12556, *12572, *12592, *12610
Electromagnets, winding....12556
Electrovegetometer....*12871
Elements, spectrum of....12774
Elevator, floating....*12699
Ellipses of equal areas....*12709
Elliptograph, simple....*12752
Embalming, new method....12882
Empress of India, ship....*12700
Enamels, Limbourg....*12801
Engine, gas, Atkinson....*12907
Engine, gas, inventor of....*12751
Engine, hydraulic, Pearsall....*12699
Engine, reciprocating elec....12512
Engine, steam, builders of....12808, 12833
Engine, steam, origin of....*12953
Engine valves....*12567
Engines, gas....12769
Engines, rolling mill....*12847
Engines of ss. Teutonic....*12585, *13002
England and France, connecting. 12712
Engraving, new process....*12727
Entablature, Greek....*12800
Entomology, applied....12538, 12564, 12575
Equatorial, Paris Observ....*12823
Erygmascope, electric....*12574
Etymology, pharmaceutical....12882
Exchange, Labor, at Paris....*12695
Exhibition at Budapest....12879
Exhibition, Internat., Chicago....12514
Exhibition, National, Italy....*12754
Exhibition, naval, royal....*12889
Expedition, arctic, Ryder's....12909
Experiment, lecture....*12534
Experiments, Dub's....*12522
Experiments, electrical....*12690
Experiments, scientific....*12786
Exploration, antarctic....12529
Explosives, effect on system....12562
Explosives, firing points....12568
Explosives, high, in warfare....12682
Eyes, testing....12570
Eyesight, photographers'....12675

F

Fabric for upholstering....*12687
Fabrics, cotton, starch for....*12770
Fabrics, knife to cut....*12651
Falls, Gullfoss, Iceland....*12715
Famagousta, mole of....*12845
Farm, ostrich, life on....12531
Fats and oils, notes on....12778
Fertilizer, kainit as....12665
Fertilizers....12884
Fever, hay, to prevent....12697
Fever, typhoid, treatment....12784
Fiber, woody, nature of....12808
Fibers, quarts....12715
Figs, culture of....*12883
Filter, Tegel water works....*12551
Filter, water, at Nantes....*12869
Fire extinguisher, Godfrey....12541
Fire, Miramichi, 1825....12653
Fire nozzles....*12662
Fires, to prevent and stop....12667
Fire-proofing....12840
Fishing, deep sea....*12638
Fishing with beam trawls....*12782
Flax, culture and prep....12527
Flood at Karlsbad....*12578
Flounder, pole....*12782
Fluorine and carbon....12534
Fousss, the....*12506
Fowls, effect certain food....*12700
France and England, connecting. 12712
Fraud, preventives of....*12732
Frets, banjo, spacing for....*12686
Frieze, cloisonne....*12799
Fruit culture under glass....*12628
Fruits, cracking of....12713
Fuel, liquid....12729
Fund, Brace, distribution....12528

G

Galls on lime leaves....*12627
Galvanometer, simple....*12691
Gauges, rain....12804
Gardens, decorated, Chicago....*12711
Gargles for diphtheria....12785
Gas engine, Atkinson....*12907
Gas engine, inventor of....*12751
Gas generator....*12624
Gas, hydrogen, act. on iron, etc....12630
Gas meter, naval....12601
Gas motor of 100 h. p....*12761
Gas motors....12769
Gas, a new....12533
Gas pipes, paper....12678
Gas system, Pintsch....12508
Gas, water....12688
Gases, kinetic theory....12654
Gases, mixtures combustion....12806
Gear cutting engine....*12607
Gear, friction, Nickle's....*12612
Gelatine plates, analysis....12941
Generator, electric, Vauhan....*12559
Germicides, diphtheria....12785
Gibraltar, view of....*12787
Ginger, Chinese, source of....12697
Glass, platinized....*12851
Globe, floral....*12711
Glove making....12686
Glycerine....12624
Gold in Columbia....12816
Gold, recovery of....12582
Goodyear, Charles....*12571
Grafting, herbaceous....12710
Grafting, skin....12507
Grain weevils, destruction....12564
Grampus, the....*12899
Grape moth....*12825
Grape vines, Amer., resistant....12506
Grapevine caterpillar....*12825
Graphometer, simple....*12906
Greenland trip, Peary's....12908
Griffon, the....*12828
Guerezas, the....*12898
Gullfoss Falls, Iceland....*12715
Gun, Mannlicher....*12505
Gun, naval, Hotchkiss....*12647
Gun, quick firing, 6 in....12873
Guns, platform for....*12519
Gunboats, U. S., new....12796

H

Hammer, pneumatic....*12762
Hand car, improved....*12835
Harbor, Colombo....*12858
Harbors, natural and artific....*12844, *12858
Harmonic, polar....*12721
Harness, blackings, etc., for....12842
Hay fever to prevent....12697
Hazels, witch....*12667
Headlight, electric....12524
Health officer, humorous....12710
Heat, from compress. of air....12763
Heat, solar, apparatus....*12653
Heating cars....*12750
Heights, measuring....*12906
Herbs, grafting of....12710
Hissarlik, excavations....*12635
Holstein or wood stone....12841
Honey, testing....12886
Hop phorodon....12538
Hornblende, artificial....12914
Hospital, St. Lawrence....*12771
Houses for fruit culture....*12628
Howitzer experiments....*12590
Hulls, metal vs. wooden....12555
Hydrastis vs. phthisis....12002
Hydraulics simplified....*12588, *12608 *12643, *12652, *12676, *12768, *12863
Hydrocarbons, spectrum of....12898
Hydrogen, action on steel....12630
Hydrogen peroxide....12717, 12899
Hydrometer, naval....*12687
Hydroquinone developer....12877

I

Illuminants, gaseous....12648, 12688, 12706
Inch, miner's....*12608
Incrustation, boiler....12843
Indian corn product, new....12865
Indian, Sitting Bull....*12562
Indians, Winnebago, arts....*12694
Introduction in telephone circ....*12902
Ingot saw, new....*12619
Infection, mechanism of....12599
Insane, asylum for, Matteawan....12810
Insane, St. Lawrence Hospital....*12771
Insects, parasitic....12539
Insects, report on....*12518, *12824
Insignia of rank, naval....*12849
Instruments for curves....*12721
Insurance, life, expense margin....12577
Integrator, new....*12680
Invention and electric science....12802
Invention, Dr. Otto's....*12751
Inventions, T. Davenport's....12744
Invisible, to measure....12755
Iodine as a detective....12727
Iron, action hydrogen on....12630
Iron-aluminum alloy....12642
Iron, corrosion of....*12848
Iron, saw for cutting....*12699
Iron used in construction....12528
Ironclad Colbert....*12567

J

Jamestown, St. Helena....*12540
Jeta....*12692

Jets, photography of *12752
Jewel, cloisonne *12709
Journal bearings, friction 12554
Journalism, associated 12729

K

Kainit 12805
Kaolin 12842
Kaolin beds 12914
Karlsbad, flood at *12578
Kieffer, Peter 12592
Knife for cutting fabrics *12650
Knot, black, of plum *12738

L

Labor Exchange, Paris *13005
Laboratory, electric, amateur *13000
Ladder Hill *12540
Ladybird, history, curious 12714
Lamp, incandescent, factory 13013
Lathe, boring and chuck *12750
Launch, electric *12558
Lavender and its varieties *12773
Laws, patent, century 12791
Leather, peculiarities of 12970
Lectures, Sibley College *12763
Lemon oil 12789
Lemon sole *12782
Leopard, snow *12818
Le Tage, war ship *12883
Life insurance expense margin 12577
Light, action on chlorine 12534
Light, head, electric 12524
Lightning rod protection 12744
Lignin, reaction for *13640
Lily of the valley 12923
Limes, oil of 12789
Linden, galls on *12927
Linseed oil, boiled 12977
Locomotion in water *12532
Locomotive, electric, Weems' *12746
Locomotive, mining *12512
Locomotive, St. Gothard road *12706
Lomarias *13606
London, O., water supply 12952
Lotus, Nile *12535
Lubricants, action of 12554
Lumber, terra cotta 12940
Lymph, Koch's 12580
Lyrse, *a*, duplicity of 12063

M

Machinery, to clean 12518
Machinery, insecticide 12504
Machines, agricult., testing *12569
Maggot, onion *12824
Magnesia cement, applic 12811
Magnet, electro .. *12522, *12547, *12556, *12572, *12582, *12610
Magnet, experiment with *12572
Magnet winder, Wood's *12521
Maize product, new 12865
Malarial maladies 12911
Maple molasses *12546
Maple, silver 12789
Marble and mosaic 12770
Mars, earth as morn. star of *12638
Matter, indestructibility *12574
Medusa, motion of *12582
Megalonyx in Ohio 12531
Melting points, determin *12521
Memory 12881
Messages, aerial *12615
Metals, allotropic forms 12774
Meteor, dispatch boat *12759
Meteorite, Oschansk *12563
Meteorology, observations in 1800 12596
Meter, gas, novel 12601
Microbe of phosphorus, wood 12712
Miner, cabbage leaf *12826
Mineral matter, separation *12560
Mines, coal, electricity in 12513
Mining, art of, progress 12880
Miramichi fire of 1825 12053
Molasses, maple *12546
Mont Blanc observatory 12576
Monte Generoso Railway *12505
Monterey, armored vessel *12855
Moon not a globe 12538
Mosaic and marble 12770
Mosaic, panels in *12720
Mosses 12870
Mosses, study of 12852
Mortars, 12-inch *12541
Moth, bud *12818
Moth, codling *12826
Moth, grape *12825
Moth, plume *12826
Motor, electric *12601
Motor, electric, Henry's *12548
Motor, electric, for organs *12525
Motor, electric, small *12510
Motor, electric, street car *12867
Motor, electric, Vauhan *12558
Motor, gas, Atkinson *12607
Motor, gas, of 100 h. p *12761
Motors, electric, railway ..12617, *12843, 12872
Motors, gas 12769
Motor, thermic, of future *12761
Mule, cotton spinning *12545
Mummy of a house dog *13002
Mummies, Amenide, Thebes *12738, 12753
Musical instruments, curious *12979
Mycenæ, antiquities from *12632
Myopia 12562

N

Nature, perseverance of *12712
Navy, royal, exhibition *12880
Navies of Europe *12776
Navigation, aerial *12543
Negatives, intensifying 12849
Newspaper, American, business end 12005, 12723
Newspapers, how made up 12728
Nelson harbor *12845
Nickel in the slot machines *12730
Niepce, house of *12804
Nozzles, fire *12652

O

Oak, white 12937
Ocean waves 12551
Oils and fats, notes on 12778
Oils for pictures 12892
Oils, lemon, lime, etc 12789
Oils, paint 12876
Onion culture for pickles 12754
Onion maggot *12824
Oranges, California 12818
Organ blowing, electric *12525
Ostrich farm, life on 12531
Otto, Dr. N. O *12751
Otto of roses *12755
Ounce *12818
Ovals of equal areas *12798
Oxygen from the air 12566
Ozone, production of 12640
Ozone water as remedy 12899

P

Paint oils 12876
Paint, to remove 12709
Panels, mosaic *12720
Paper gas pipes 12678
Patent laws, century of 12791
Patents, protection by 12841
Pathology, newer 12579
Pavement tiles *12801
Pea weevil *12830
Peach yellows 12742
Peary, Greenland trip of 13008
Pelayo, cruiser *12777
Perfumes, flower, how made *12731
Perspective, photographic 12813
Petroleum in South Africa 12508
Pharmacy, examination in 12912
Philadelphia port of entry *12642
Phonograph, note on 13018
Phonophore *12722
Phosphate deposits, Florida 13064
Phosphorescence in vacua *12705
Phosphorus, action of light 12540
Phorodon, hop 12538
Photochronography, app. for *12533
Photo-electricity 12894
Photographs projected in color *12671
Photographers, eyesight of 13075
Photos. in printing ink 12720
Photography, automatic *12850
Photography in colors of nature *12671, 12780, *12878
Photography, instantaneous *12894
Photography of jets *12752
Photography of locomotion *12532
Photography, pyrotechnical 12805
Photography, tele *12559
Phthisis, hydrastis 13002
Phthisis, philosophy of 12694
Phylloxera 12538, 12596
Physiology, animal, researches *12532
Physiology, newer 12879
Picnometer, areo *12687
Pictures, durability of 12892
Pictures, transmission, electric *12558, *12559
Pier, Dover *12858
Pinus ponderosa *12536
Pipes, galvanized iron 12897
Pipes, gas, paper 12678
Pintsch gas, system of 12508
Planets, revolution of, cause 12904
Plant, laughing 12790
Plants, dissemination *12535
Plants, effect electricity *12871
Plants, fibrous, disintegrating *12560
Plaster of Paris, manufacture 12985
Plates, gelatine, analysis 12641
Platform for guns at sea *12519
Plating, dynamo for *12674
Plum curculio *12820
Plum tree, black knot of *12738
Plume moth *12836
Plymouth breakwater *12858
Pointers *12827
Polarization without polarizer 12678
Police apparatus, electric 12721
Polishers, harness 12842
Pop-gun, electromagnetic *12573
Port Jackson *12845
Port Philip *12845
Portrait, multiple *12621
Position finder, Fiske's *12580
Potash, permang., bleaching by 12758
Potash salts 12576
Potato starch *12770
Pottery, cellular 12940
Power, transmission, by cable *12564
Power, transmission, electric *12511
Power, water, electric utilizn 12815
Preserves, Indian 12713
Pressure, osmotic, law of *12830
Prizes, Paris Acad. Sci 13042
Projection apparatus, balance *12709
Projections, stereoscopic *12708
Propeller, screw, physics of 12776
Propeller, screw, steering *12749
Propulsion, wave power *12520
Pulitzer building 12878
Pump air, new *12905
Pyrogravure *12727

Q

Quartz fibers 12715

R

Radiant matter *12714
Railroad, cogwheel, new *12505
Railroad tracks, spiking 12681
Railroading, electric ..12617, *12643, 13072
Railway bridges 12543
Railway, electric, conduit *12673, *12815
Railway, electric, notes on 12722
Railway, Metropol., Paris *12504
Railway, Monte Generoso *12505
Railway, multiple dispatch *12719
Railway through the Andes *12699
Railway ties, preservation 12900
Railway, transandine *12800
Railway, rope *12874
Railway work, electric, fast *12745
Rain gauges 12804
Ram, hydraulic *13676
Range finder *12670
Range finder, Fiske's *12580, *12805
Resin oil 12877
Retort, continuous feed *12553
Rank devices, naval *12849
Rice starch *12770
Rifle, German, new *12505
Rifle, Mannlicher *12748
Rio de Janeiro *12844
Roman remains *12537
Roman remains, Silchester *12595
Roots, extracting 12714
Rope, wire, Midgley *12554
Ropeway, wire *12749
Ropeway, wire cable *12874
Ropeways, wire *12619
Rolling mill engines *12847
Roses, otto of *12755
Royal Arthur, ship *12808
Royal Sovereign, ship *12807
Ryder, arctic expedit. of 12909

S

Sago starch *12770
Salmon, migration of *12613
Sand dab *12782
Sand washer *12552
Savannah, steamer *12795
Saw, hot, oscillating *12619
Saw, iron, cold *12699
Saw, stone, circular *12777
Sawing machines, tree *12606
Schliemann, H *12631, 12635
Science, electric, and invention 12902
Science in the theater *12578
Scrapers, earth, various *12734
Screening, electric, etc *12814
Screw propeller, physics of 12776
Sea horse, fin, motion *12532
Seaport, Chicago as *12700
Sea wall, mining *12750
Seborrhœa 12945
Sections, conic *12826
Seeds, distribution *12535
Seine, restocking *12828
Selenium, uses of 12566
Semen, crystals in 12669
Setters *12827
Sewage, purification of 12772
Sewage, treatment of *12570
Shadows, a study of *12911
Shed, train, Chicago *12748
Ship, armored, Monterey *12855
Ship Empress of India *12700
Ship Royal Arthur *12808
Ship Royal Sovereign *12807
Ship Savannah *12795
Ship Ulunda, raising of *12759
Ship, U. S., Charleston *12555
Ship Utopia, sinking *12787
Ship, war, armored *12630
Ship, war, Le Tage *12880
Ship of war Colbert *12567
Ship, war, De Mayo *12503
Ship, war, Meteor *12759
Ship, war, Pelayo *12777
Ships of war, designs, new 12733
Short-sightedness 12502
Signaling without wires *12615
Signatures, erased, detection 12742
Silicon, the element 12678
Silk, bleaching 12614
Silk culture 12565
Silver, recovery of 12582
Siphons *12676
Sitting Bull *12502
Skin grafting 12507
Sleep, induced, simulating *12578
Sloth, fossil, Ohio 12531
Smoke particles *12051
Snakes, eggs of, incubation 12563
Snow leopard *12818
Snow sweeper, electric *12594
Soap films, photography *12752
Soap for wool washing 12854
Soaps, floating 12904
Soda developer 12977
Society, Chemical, American 12508
Society, Chemical, London ..12725, 12740
Society, meteorolog., exhib 12804
Sole, cock *12782
Sole, lemon *12782
Sound, velocity of 12880
Sound, velocity under water *12616
Spectrum of hydrocarbons 12800
Spectrum of the sun 12774
Spirits, maturing of *13001
Spirograph, the *12005
Spoil distributer *12699
Spree, steamer *12847
Squash bug *12819
Stalk borer *12825
Stand, type, new *12545
Starches for cotton fabrics *12770
Station, Grand Central, Chicago *12748
Statoscope *12906
Steamboat, theatrical *12578
Steamer, French, Bourgogne *12888
Steamer, ocean, first *12795
Steamer Spree, German *12847
Steamer Teutonic *12583, *13002
Steamers, liquid fuel in 12727
Steel, act. of hydrogen on 12630
Steel, aluminum 12712
Steel, artillery, tests for 12856
Steel making in Spain 12678
Steel process, open hearth *12590
Stereoscope, projections from *12708
Stereotyping *12621
St. Helena, views in *12540
Stone, monumental *12801
Stone saw, circular *12777
Stone, wood 12841
Street car motor, electric *12866
Sugar in tablets *12599
Sun dial, floral *12711
Sun, spectrum of 12774
Sweeper, snow, electric *12594

T

Tallow, solidifying points *12560
Tannin for boiler crust 12561
Tannin, removal from tea 12886
Tanning, electrical *12534
Tanning materials of Europe 12837
Tapioca starch *12770
Target, ballistic, electric *12574
Tea, to remove tannin from 12886
Technologist, Swiss, on America 12888
Tegel water works *12551
Telegrams, aerial *12615
Telegraph line, duplex app *12722
Telegraph lines, submarine *12702
Telegraph, magnetic 12075
Telegraphy, early work in 12744
Telegraphy without wires *12615
Telephany *12559, *12645
Telephone circuits, disturb. in *12802
Telephone industry 12854
Telephone, inventors of 12894
Tele-photography *12559
Telescope, great, Paris *12823
Telescope, photographic *12027
Tent caterpillar *12825
Terra cotta lumber 12840
Test card hints 12570
Tests, blowpipe 12896
Teutonic, steamer *12583, *13002
Theater, science in *12578
Thebes, Amenide mummies at 12753
Thebes, discoveries, recent *12738
Thermometer, baroscopic *12811
Thermometer, transmitting *12549
Thermosiphon for cars *12750
Ties, railway, preservation of 12900
Tiles, pavement *12801
Timber, preservation of 12900
Tin from tin scrap 12518, 12756
Tobacco factory, Turkish *12506
Toning and fixing bath 12878
Tools, to clean 12518
Tornadoes, loss of life from 12902
Tower, proposed, Chicago *12846
Tower, the Proctor 12718
Track, spiking, hints on 12681
Trades unions, tendency 12702
Train shed, Chicago *12748
Tramway, Rainey Bank *12740
Transplanting trees 12597
Trawl, beam, in United States *12782
Trawls, deep sea *12630
Tree cutting machinery *13003
Trees, age to transplant 12597
Triceratops, restoration *12804
Trombone, simple *12879
Troy, excavations at *12633
Tube, flexible *12926
Tubes, glass, heating in *12868
Tuberculosis, treatment *12822
Tunneling, water power in 12906
Tunnels, ventilation of *12587
Turbines, inventor of *12701
Type stand, new *12545

U

Ulunda, raising of *12759
Units, electric, pres. and future 12736
Urinalysis 12902
Utopia, ship, sinking *12787

V

Valve, inlet, piston *12706
Valve, perfect, requirements *12605
Valves, steam engine *12567
Varnish, to remove 12709
Varnishes for pictures 12892
Vegetable tissues, preserving 12882
Vegetables, cracking of 12712
Ventilation of tunnels *12587
Venus, visit to, imaginary ..12625, *13037
Vessel, war, Meteor *12759
Violets, double 12788
Vision at a distance *12645
Volcano, imitation of *12786
Volutes, drawing *12905
Vortices, experiments on *12063

W

Wall, sea, mining *12750
Warfare, high explosives in 12682
War ship Colbert *12567
War ship De Mayo *12503
War ship designs, recent 12732
War ship Le Tage *12888
War ship Pelayo *12777
War ship Royal Sovereign *12807
War vessel, armored *12630
War vessel, Meteor *12759
Waters, carbonated, manuf *12624
Water changed to wine *12786
Water, decomposition of *12691
Water, filtered, at Nantes *12869
Water, flow through pipes *12643
Water plays, theatrical *12578
Water, potable, pipes for 12897
Water, power of .. *12588, *12608, *12643, *12652, *12676, *12768, *12863
Water power, electric utilization 12815
Water power in tunneling 12503
Water, purification, electric 14772
Waterproof, harness 12842
Water softening apparatus *12570
Waterspouts, study of *12663
Water supply, London, O 12653
Water wheels *12863
Water works, Tegel *12551
Waves, ocean 12551
Wave power propulsion *12520
Weevils, grain, destruct 12564
Weevils, pea and bean *12830
Weights, atomic, table of 12837
Welding, electric *12546
Well, artesian, Dakota *12865
Well, filtering, Lefort *12869
Wells, artesian, pipes for 12897
Whale catching, Pt. Barrow 12787
Wheat starch *12770
Wheel cutting, new mode *12607
Wheels, car, diameter 12679
Wheels, current, power *12768
Wheels, water *12863
Whirlwinds, study of *12663
Whisky 12821
Windlass, helicoidal *12777
Winnebago arts 12693
Wire rope, Midgley *12554
Wire ropeways *12619
Witch hazels *12667
Wood, brick 12841
Wood fiber, nature of 12868
Wood, phosphorescent, microbe 12712
Wood stone 12841
Wool, bleaching of 12614
Wool washing, soap for 12854
World, the New York 12878
Writings, fraudulent, detect 12727

Y

Yachts, centerboard, on Clyde 12875
Yachts, steam, modern *12520
Yellows of the peach 12742
Yorktown, gunboat 12796